R/V Mirai Cruise Report
MR11-07

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

Members on Leg-1 (Photo on Oct.26)

Members on Leg-2 (Photo on Nov.30)

MR11-07 Cruise Report
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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 Indian Ocean through the western Pacific Ocean.

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, fine-scale observation data is invaluable to promote our knowledge on the mechanism of the MJO.

In 2006, we JAMSTEC conducted the field campaign named MISMO (Mirai Indian Ocean cruise for the Study of the MJO-convection Onset) during R/V Mirai MR06-05 cruise. The project captured the activation phase of an intraseasonal variation, or "aborted MJO", and reveals that the zonally-propagating disturbances play important roles. For the further analyses, on the other hand, it is desired in the upcoming projects to elongate the observation period to capture the whole cycle of MJO(s) with finer spatial / temporal structure in higher accuracy.

To achieve further detailed understanding of MJO over the Indian Ocean, we have again organized the international project CINDY2011 (Cooperative Indian Ocean Experiments on Intraseasonal Variability in the Year 2011). With the cooperation of various countries, especially the project DYNAMO (Dynamics of the Madden-Julian Oscillation) from the United States, the field campaign was planned from October 2011 to January 2012. The R/V Mirai MR11-07 cruise was carried out as a component of the CINDY2011 field campaign.

The cruise consists of two legs in October and November. During the cruise, we basically stayed (8S, 80.5E) to obtain continuous and high temporal-resolution data set for both atmospheric and oceanic states. The principle component of the observations are the surface meteorological measurement, atmospheric sounding by radiosonde, CTD casting, ADCP current measurement, oceanic profile of the turbulent mixing, as well as Doppler radar observation. In addition, bio-geochemical parameters on the sampled water, turbulent flux measurement, Mie-scattering LIDAR, vertical-pointing cloud radar, ozone and water vapor sonde, and other many observations were intensively conducted. Furthermore, the continuous observations are also carried out on the way to and back from the (8S, 80.5E) station, to capture the spatial and temporal variation of the atmospheric and oceanic status.

This cruise report summarizes the observed items and preliminary results during this cruise. 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. Additional information and figures are also attached as Appendices.

With this cruise report, the information about the CINDY2011 project and MR11-07 cruise could be referred at CINDY2011 web site (http://www.jamstec.go.jp/iorgc/cindy/).

***** Remarks *****

This cruise report is a preliminary documentation as of the end of the cruise. The contents may be not updated after the end of the cruise, while the contents may be subject to change without notice. Data on the cruise report may be raw or not processed. Please ask the Chief Scientists for the latest information.

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

MR11-07

2.3 Project Name (Main mission)

Observational Study on the Intraseasonal Variability in the Indian Ocean
(as a component of an international project "CINDY2011"
[Cooperative Indian Ocean Experiment on Intraseasonal Variability in the Year 2011])

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

For Leg-1:
Kunio YONEYAMA
Tropical Climate Variability Research Program,
Research Institute for Global Change, JAMSTEC

For Leg-2:
Masaki KATSUMATA
Tropical Climate Variability Research Program,
Research Institute for Global Change, JAMSTEC

2.6 Periods and Ports of Call

Sep. 26:	departed Singapore
Oct. 27-28:	called Colombo, Sri Lanka
Dec. 02:	arrived Colombo, Sri Lanka

2.7 Research Themes of Sub-missions and Principal Investigators (PIs)

(1) Observational and modeling analyses of the effects of multi-scale moisture variability on the organization of meso-scale convective systems.
(PI: Tetsuya Takemi / Kyoto University)

(2) Validation of daily simulation results using a cloud-resolving model over the tropical Indian Ocean.
(PI: Taroh Shinoda / Nagoya University)

(3) On-board continuous air-sea flux measurement.
(PI: Osamu Tsukamoto / Okayama University)

(4) Observation study on ozone and water vapor variability in the tropical tropopause layer.

(PI: Masatomo Fujiwara / Hokkaido University)

(5) Distribution and configuration of clouds in various Oceans.
(PI: Toshiaki Takano / Chiba University)

(6) Lidar observations of optical characteristics and vertical distribution of aerosols and clouds.
(PI: Nobuo Sugimoto / National Institute for Environmental Studies)

(7) Maritime aerosol optical properties from measurements of ship-borne sky radiometer.
(PI: Kazuma Aoki / Toyama University)

(8) Tropospheric aerosol and gas observations on a research vessel by MAX-DOAS.
(PI: Hisahiro Takashima / JAMSTEC)

(9) Water sampling for building water isotopologue map over the Ocean.
(PI: Naoyuki Kurita / JAMSTEC)

(10) Distribution and ecology of oceanic Halobates inhabiting tropical area of Indian Ocean and their responding system to several environmental factors.
(PI: Tetsuo Harada / Kochi University)

(11) Standardising the marine geophysics data and its application to the ocean floor geodynamics studies.
(PI: Takeshi Matsumoto / University of the Ryukyu)

2.8 Observation Summary

GPS Radiosonde	500 times	Sep.25 to Oct.26 / Oct.29 to Dec.01
5.3-GHz Doppler radar	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Disdrometer	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
95-GHz cloud profiling radar	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Mie-scattering LIDAR	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
High Spectral Resolving LIDAR	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Ceilometer	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
GPS water vapor measurement	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Sky Radiometer	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
MAX-DOAS	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Surface Meteorology	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Atmospheric turbulent flux	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Sea surface water monitoring	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
CTDO profiling	423 profiles	Sep.28 to Oct.24 / Oct.30 to Nov.29
Sea water sampling	211 casts	Sep.30 to Oct.24 / Oct.30 to Nov.28
Oceanic microstructure profiling	874 profiles	Sep.30 to Oct.24 / Oct.30 to Nov.28
LADCP	422 profiles	Sep.29 to Oct.24 / Oct.30 to Nov.29
Shipboard ADCP	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Deploying Argo float	1 time	Sep.29
Sea skater sampling	36 times	Sep.30 to Oct.22 / Oct.30 to Nov.24
Rain and water vapor sampling	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Gravity/Magnetic force	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01
Topography	continuously	Sep.25 to Oct.26 / Oct.29 to Dec.01

2.9 Overview

In order to investigate the atmospheric and oceanic variations in the central equatorial Indian Ocean and their role in the intraseasonal variation, especially Madden-Julian Oscillation (MJO), the intensive observations by using R/V Mirai were carried out. This cruise was a component of the international field campaign named CINDY/DYNAMO (Cooperative Indian Ocean Experiment for the Intraseasonal Variation in Year 2011 / Dynamic of Madden-Julian Oscillation) to form the quadrilateral observation array with R/V Roger Revelle at (Eq, 80E), Addu Atoll at (Eq, 73E), and Diego Garcia (7S, 72E).

The most of the cruise days in both Leg-1 and Leg-2 were dedicated to perform stationary observation at (8.0S, 80.5E) to obtain high-resolution time series of the oceanic and atmospheric variations. She was at the station for 52 days in total, from Sep.30 to Oct.24 in Leg-1 and from Oct.31 to Nov.28 in Leg-2.

During the observation period, two events of the convectively active phase of MJO (hereafter "MJO") rose in the CINDY/DYNAMO array, as in the index by Wheeler and Hendon (2004). The characteristics over Mirai at 8S were very different between two events. The observed atmospheric and oceanic profiles were successfully captured as in, for example, in Figs. 5.1-1 and 5.1-2 (by radiosonde), Fig. 5.2-1 (by Doppler radar), Fig. 5.14-1 (by CTDO), etc.

Over Mirai, active convection and moist atmosphere were observed in the former half of Leg-1. The high temperature and low salinity in the oceanic surface mixing layer (hereafter "oceanic surface layer") were reasonably observed during the convectively active period. The situation turned suddenly into convectively inactive in the latter half of Leg-1. Though the oceanic surface layer gradually deepened and was warmed gradually with the apparent diurnal cycle, the atmosphere kept dry and convectively inactive. In the end of Leg-1, the first MJO was apparent on the equator and northern hemisphere side of the CINDY/DYNAMO array, without any active convection over Mirai.

In Leg-2, second MJO event was apparent also in the end of the Leg. Toward the MJO, the atmospheric condition gradually changed as in precipitable water and radar echo coverage, with the variation of several days. Oceanic surface layer is limited as about 40-meter depth where the diurnal warming was observed continuously thru Leg-2. Drastic changes of the oceanic parameters were also observed in the middle of Leg-2.

These observed results will be analyzed further, with combining the data from other platforms deployed over the CINDY/DYNAMO array over the central Indian Ocean. Two of them were also deployed in this cruise: a subsurface buoy and an ARGO-type float. These were deployed at (5S, 78E) on September 29, to obtain the meteorological and oceanic data within the CINDY/DYNAMO southern array. The former equipped the acoustic Doppler current profiler (ADCP) to capture the oceanic current above 200m depth, as well as the passive acoustic listener (PAL) to monitor the rainfall and wind speed at ocean surface. The subsurface buoy was successfully recovered at the end of the cruise on Nov.29. The ARGO-type float also reported daily oceanic profiles continuously.

These observed data revealed detailed meridional structure of the MJO, in which the zonal structure had been highlighted in the previous studies. The further analyses for the obtained data will be performed to engrave the detail of the processes to spawn the convectively active phase of the MJO.

2.10 Acknowledgments

We would like to express our sincere thanks to Captain Y. Ishioka and his crew for their skillful ship operation. 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. Supports from collaborators in the project CINDY/DYNAMO are acknowledged.

3. Cruise Track and Log

3.1 Cruise Track

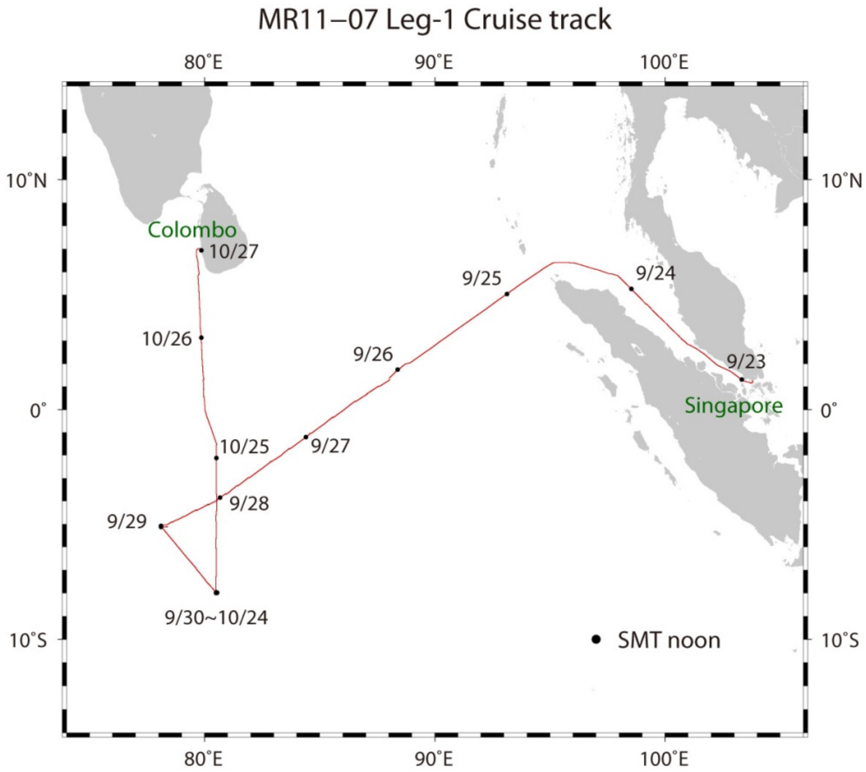


Fig. 3.1-1: Cruise Track for Leg-1. Black dots are for the position at local (SMT) noon.

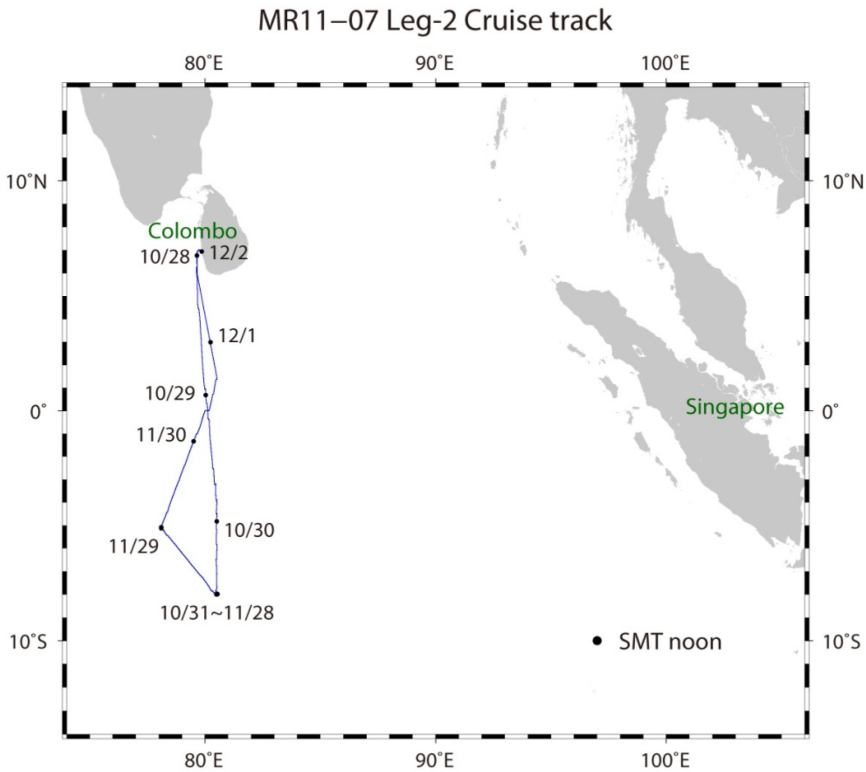


Fig. 3.1-2: Same as Fig. 3-1 but for Leg-2.

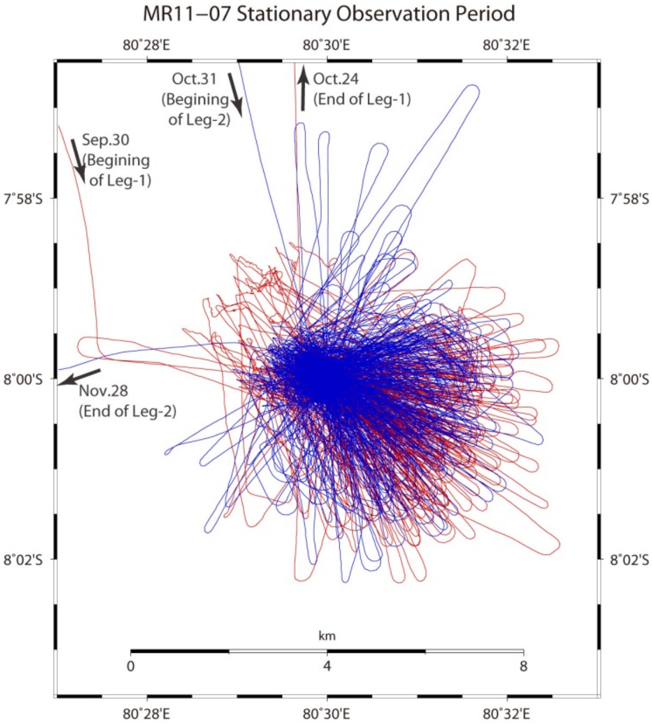


Fig. 3.1-3: Cruise track around the station (8S, 80.5E), both for Leg-1 (red) and Leg-2 (blue).

3.2 Cruise Log

Date	SMT/UTC	Position and Events	
Sep. 23	0900/0100	Departure from Singapore	
25	2040/1340	Starting Doppler radar observation	
	----/1500	Revision of Ship Mean Time (to UTC+6h)	
26	1132/0532	(01-47N, 088-27E)	Radiosonde (#001)
	1452/0852	(01-17N, 088-01E)	Radiosonde (#M001)
	1730/1130	(01-01N, 089-34E)	Radiosonde (#002)
	2029/1429	(00-41N, 087-04E)	Radiosonde (#M002)
	----/1600	Revision of Ship Mean Time (to UTC+5h)	
	2230/1730	(00-22N, 086-32E)	Radiosonde (#003)
27	0432/2332	(00-20S, 085-34E)	Radiosonde (#004)
	1031/0531	(01-02S, 084-37E)	Radiosonde (#005)
	1630/1130	(01-42S, 083-41E)	Radiosonde (#006)
	1822/1322	(01-55S, 083-24E)	Sea skater collection (#001-1)
	1842/1342	(01-56S, 083-24E)	Sea skater collection (#001-2)
	1901/1401	(01-56S, 083-24E)	Sea skater collection (#001-3)
	2230/1730	(02-17S, 082-53E)	Radiosonde (#007)
28	0430/2330	(02-58S, 081-55E)	Radiosonde (#008)
	0731/0231	(03-20S, 081-25E)	Radiosonde (#009)
	1030/0530	(03-41S, 080-55E)	Radiosonde (#010)
	1300/0800	(04-00S, 080-30E)	RAMA buoy inspection
	1330/0830	(03-60S, 080-30E)	Radiosonde (#011)
	1333/0833	(03-60S, 080-30E)	CTD (#001; 1000m), With sampling seawater
	1630/1130	(04-09S, 080-09E)	Radiosonde (#012)
	1930/1430	(04-24S, 079-38E)	Radiosonde (#013)
	2230/1730	(04-40S, 079-07E)	Radiosonde (#014)
29	0130/2030	(04-55S, 078-34E)	Radiosonde (#015)
	0231/2121	(05-00S, 078-25E)	XCTD (#001)
	0431/2331	(05-04S, 078-04E)	Radiosonde (#016)
	0633/0133	(05-08S, 078-22E)	Testing 3-dimensional magnetometer

	0731/0231	(05-08S, 078-18E)	Radiosonde (#017)
	0855/0355	(05-07S, 078-03E)	Deploy sub-surface ADCP mooring
	1055/0555	(05-05S, 078-06E)	Radiosonde (#018)
	1258/0758	(05-07S, 078-06E)	CTD (#002; 1000m), With sampling seawater
	1331/0831	(05-07S, 078-07E)	Radiosonde (#019)
	1359/0859	(05-07S, 078-07E)	Argo float deployment
	1630/1130	(05-31S, 078-27E)	Radiosonde (#020)
	1931/1431	(06-01S, 078-51E)	Radiosonde (#021)
	2300/1800	(06-35S, 079-20E)	Radiosonde (#022)
30	0130/2030	(06-58S, 079-38E)	Radiosonde (#023)
	0432/2332	(07-26S, 080-00E)	Radiosonde (#024)
	0730/0230	(07-52S, 080-23E)	Radiosonde (#025)
	1012/0512		Deploy "Sea-Snake" SSST sensor
	1030/0530	(07-59S, 080-30E)	Radiosonde (#026)
	1034/0534	(07-59S, 080-30E)	CTD (#003; 1000m), With sampling seawater
	1145/0645	(07-59S, 080-30E)	TurboMAP (#001; 300m)
	1157/0657	(07-59S, 080-30E)	Radiosonde (#M003)
	1210/0710		Flux (#001)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#027)
	1332/0832	(08-10S, 080-30E)	CTD (#004; 500m)
	1403/0903	(07-90S, 080-29E)	TurboMAP (#002; 300m)
	1430/0930		Flux (#002)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#028)
	1633/1133	(08-00S, 080-29E)	CTD (#005; 500m), With sampling seawater
	1722/1222	(08-00S, 080-30E)	TurboMAP (#003; 300m)
	1745/1245		Flux (#003)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#029)
	1933/1433	(08-00S, 080-30E)	CTD (#006; 500m)
	2005/1505	(07-59S, 080-29E)	TurboMAP (#004; 300m)
	2033/1533	(07-59S, 080-30E)	Sea skater collection (#002-1)
	2052/1552	(08-00S, 080-30E)	Sea skater collection (#002-2)
	2112/1612	(08-00S, 080-30E)	Sea skater collection (#002-3)
	2135/1635		Flux (#004)
	2230/1730	(07-59S, 080-29E)	Radiosonde (#030)
	2232/1732	(08-00S, 080-30E)	CTD (#007; 500m), With sampling seawater
	2323/1823	(07-59S, 080-29E)	TurboMAP (#005; 300m)
	2355/1855		Flux (#005)
Oct. 1	0130/2030	(08-00S, 080-29E)	Radiosonde (#031)
	0131/2031	(08-00S, 080-29E)	CTD (#008; 500m)
	0203/2103	(07-59S, 080-29E)	TurboMAP (#006; 300m)
	0225/2125		Flux (#006)
	0431/2331	(07-59S, 080-29E)	Radiosonde (#032)
	0434/2334	(08-00S, 080-29E)	CTD (#009; 500m), With sampling seawater
	0522/0022	(07-59S, 080-29E)	TurboMAP (#007; 300m)
	0550/0050		Flux (#007)
	0730/0230	(08-00S, 080-29E)	Radiosonde (#033)
	0734/0234	(08-00S, 080-29E)	CTD (#010; 500m)
	0806/0306	(07-59S, 080-29E)	TurboMAP (#008; 300m)
	0830/0330		Flux (#008)
	1030/0530	(08-00S, 080-29E)	Radiosonde (#034)
	1035/0535	(07-59S, 080-29E)	CTD (#011; 1000m), With sampling seawater
	1141/0641	(07-59S, 080-29E)	TurboMAP (#009-1; 300m)
	1159/0659	(07-59S, 080-29E)	TurboMAP (#009-2; 300m)
	1220/0720		Flux (#009)
	1331/0831	(08-00S, 080-29E)	Radiosonde (#035)
	1336/0836	(08-00S, 080-29E)	CTD (#012; 500m)
	1405/0905	(08-00S, 080-29E)	TurboMAP (#010-1; 300m)
	1425/0925	(08-00S, 080-29E)	TurboMAP (#010-2; 300m)
	1446/0946		Flux (#010)
	1630/1130	(07-59S, 080-29E)	Radiosonde (#036)
	1647/1147	(07-59S, 080-29E)	CTD (#013; 500m), With sampling seawater

	1655/1155	(07-59S, 080-29E)	Radiosonde (#037)
	1733/1233	(07-59S, 080-29E)	TurboMAP (#011-1; 300m)
	1752/1252	(07-59S, 080-29E)	TurboMAP (#011-2; 300m)
	1815/1315		Flux (#011)
	1930/1430	(08-00S, 080-29E)	Radiosonde (#038)
	1940/1430	(08-00S, 080-29E)	CTD (#014; 500m)
	2013/1513	(07-59S, 080-29E)	TurboMAP (#012-1; 300m)
	2031/1531	(07-59S, 080-29E)	TurboMAP (#012-2; 300m)
	2057/1557	(07-59S, 080-29E)	Sea skater collection (#003-1)
	2118/1618	(07-59S, 080-29E)	Sea skater collection (#003-2)
	2138/1638	(08-00S, 080-29E)	Sea skater collection (#003-3)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#039)
	2239/1739	(07-59S, 080-29E)	CTD (#015; 500m), With sampling seawater
	2230/1730	(07-59S, 080-28E)	TurboMAP (#013-1; 300m)
	2248/1748	(07-59S, 080-28E)	TurboMAP (#013-2; 300m)
2	0010/1910		Flux (#012)
	0130/2010	(07-59S, 080-29E)	Radiosonde (#040)
	0138/2038	(07-59S, 080-29E)	CTD (#016; 500m)
	0210/2110	(07-59S, 080-29E)	TurboMAP (#014-1; 300m)
	0227/2127	(07-59S, 080-28E)	TurboMAP (#014-2; 300m)
	0245/2145		Flux (#013)
	0431/2331	(07-59S, 080-29E)	Radiosonde (#041)
	0437/2337	(07-59S, 080-29E)	CTD (#017; 500m), With sampling seawater
	0527/0027	(07-59S, 080-29E)	TurboMAP (#015-1; 300m)
	0546/0046	(07-59S, 080-29E)	TurboMAP (#015-2; 300m)
	0615/0115		Flux (#014)
	0731/0231	(07-59S, 080-29E)	Radiosonde (#042)
	0743/0243	(07-59S, 080-30E)	CTD (#018; 500m)
	0815/0315	(07-59S, 080-30E)	TurboMAP (#016-1; 300m)
	0834/0334	(07-59S, 080-30E)	TurboMAP (#016-2; 300m)
	0853/0353		Flux (#015)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#043)
	1035/0530	(07-59S, 080-30E)	CTD (#019; 1000m), With sampling seawater
	1137/0637	(07-59S, 080-30E)	TurboMAP (#017-1; 300m)
	1205/0705	(07-59S, 080-30E)	TurboMAP (#017-2; 300m)
	1225/0725		Flux (#016)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#044)
	1338/0838	(08-00S, 080-30E)	CTD (#020; 500m)
	1411/0911	(07-59S, 080-29E)	TurboMAP (#018-1; 300m)
	1432/0932	(07-59S, 080-29E)	TurboMAP (#018-2; 300m)
	1455/0955		Flux (#017)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#045)
	1638/1138	(08-00S, 080-29E)	CTD (#021; 500m), With sampling seawater
	1725/1225	(07-59S, 080-29E)	TurboMAP (#019-1; 300m)
	1744/1244	(07-59S, 080-29E)	TurboMAP (#019-2; 300m)
	1805/1305		Flux (#018)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#046)
	1939/1439	(08-00S, 080-29E)	CTD (#023; 500m)
	2013/1513	(07-59S, 080-29E)	TurboMAP (#020-1; 300m)
	2030/1530	(07-59S, 080-29E)	TurboMAP (#020-2; 300m)
	2050/1530		Flux (#019)
	2230/1730	(07-59S, 080-29E)	Radiosonde (#047)
	2238/1738	(08-00S, 080-29E)	CTD (#023; 500m), With sampling seawater
	2328/1828	(07-59S, 080-29E)	TurboMAP (#021-1; 300m)
	2347/1847	(07-59S, 080-29E)	TurboMAP (#021-2; 300m)
3	0007/1907		Flux (#020)
	0130/2030	(08-00S, 080-29E)	Radiosonde (#048)
	0137/2037	(08-00S, 080-29E)	CTD (#024; 500m)
	0208/2108	(08-00S, 080-29E)	TurboMAP (#022-1; 300m)
	0227/2127	(08-00S, 080-29E)	TurboMAP (#022-2; 300m)
	0248/2148		Flux (#021)

	0431/2331	(07-59S, 080-30E)	Radiosonde (#049)
	0434/2334	(08-00S, 080-30E)	CTD (#025; 500m), With sampling seawater
	0530/0030	(08-00S, 080-29E)	TurboMAP (#023-1; 300m)
	0549/0049	(08-00S, 080-29E)	TurboMAP (#023-2; 300m)
	0610/0110		Flux (#022)
	0731/0231	(07-59S, 080-30E)	Radiosonde (#050)
	0736/0236	(08-00S, 080-30E)	CTD (#026; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#024-1; 300m)
	0830/0330	(08-00S, 080-30E)	TurboMAP (#024-2; 300m)
	0852/0352		Flux (#023)
	1030/0530	(07-59S, 080-30E)	Radiosonde (#051)
	1035/0535	(08-00S, 080-30E)	CTD (#027; 1000m), With sampling seawater
	1139/0639	(08-00S, 080-30E)	TurboMAP (#025-1; 300m)
	1157/0657	(08-00S, 080-30E)	TurboMAP (#025-2; 300m)
	1218/0718		Flux (#024)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#052)
	1336/0830	(08-00S, 080-30E)	CTD (#028; 500m)
	1408/0908	(08-00S, 080-30E)	TurboMAP (#026-1; 300m)
	1430/0930	(08-00S, 080-30E)	TurboMAP (#026-2; 300m)
	1453/0953		Flux (#025)
	1631/1131	(08-00S, 080-29E)	Radiosonde (#053)
	1635/1135	(08-00S, 080-29E)	CTD (#029; 500m), With sampling seawater
	1727/1227	(08-00S, 080-29E)	TurboMAP (#027-1; 300m)
	1745/1245	(08-00S, 080-29E)	TurboMAP (#027-2; 300m)
	1808/1308		Flux (#026)
	1930/1430	(07-59S, 080-29E)	Radiosonde (#054)
	1937/1437	(07-59S, 080-29E)	CTD (#030; 500m)
	2014/1514	(07-59S, 080-29E)	TurboMAP (#028-1; 300m)
	2032/1532	(07-59S, 080-29E)	TurboMAP (#028-2; 300m)
	2056/1556	(07-59S, 080-29E)	Sea skater collection (#004-1)
	2114/1614	(08-00S, 080-29E)	Sea skater collection (#004-2)
	2134/1634	(08-01S, 080-30E)	Sea skater collection (#004-3)
	2230/1730	(07-59S, 080-30E)	Radiosonde (#055)
	2237/1737	(07-59S, 080-29E)	CTD (#031; 500m), With sampling seawater
	2324/1824	(07-59S, 080-30E)	TurboMAP (#029-1; 300m)
	2344/1844	(07-59S, 080-30E)	TurboMAP (#029-2; 300m)
4	0002/1902		Flux (#027)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#056)
	0135/2035	(08-00S, 080-30E)	CTD (#032; 500m)
	0211/2111	(08-00S, 080-30E)	TurboMAP (#030-1; 300m)
	0230/2130	(07-59S, 080-30E)	TurboMAP (#030-2; 300m)
	0248/2148		Flux (#028)
	0430/2330	(08-00S, 080-29E)	Radiosonde (#057)
	0436/2336	(07-59S, 080-29E)	CTD (#033; 500m), With sampling seawater
	0526/0026	(07-59S, 080-29E)	TurboMAP (#031-1; 300m)
	0546/0046	(07-59S, 080-29E)	TurboMAP (#031-2; 300m)
	0606/0106		Flux (#029)
	0731/0231	(08-00S, 080-30E)	Radiosonde (#058)
	0736/0236	(08-00S, 080-30E)	CTD (#034; 500m)
	0810/0310	(08-00S, 080-30E)	TurboMAP (#032-1; 300m)
	0827/0327	(08-00S, 080-30E)	TurboMAP (#032-2; 300m)
	0850/0350		Flux (#030)
	1031/0531	(08-00S, 080-30E)	Radiosonde (#059)
	1036/0536	(08-00S, 080-30E)	CTD (#035; 1000m), With sampling seawater
	1140/0640	(08-00S, 080-30E)	TurboMAP (#033-1; 300m)
	1200/0700	(08-10S, 080-30E)	TurboMAP (#033-2; 300m)
	1222/0722		Flux (#031)
	1331/0831	(08-10S, 080-30E)	Radiosonde (#060)
	1337/0837	(08-00S, 080-30E)	CTD (#036; 1000m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#034-1; 300m)
	1430/0930	(07-59S, 080-30E)	TurboMAP (#034-2; 300m)

	1452/0952		Flux (#032)
	1630/1130	(07-59S, 080-29E)	Radiosonde (#061)
	1636/1136	(07-59S, 080-29E)	CTD (#037; 500m), With sampling seawater
	1722/1222	(07-59S, 080-29E)	TurboMAP (#035-1; 300m)
	1742/1242	(07-59S, 080-29E)	TurboMAP (#035-2; 300m)
	1806/1306		Flux (#033)
	1930/1400	(07-59S, 080-29E)	Radiosonde (#062)
	1936/1436	(07-58S, 080-29E)	CTD (#038; 500m)
	2009/1509	(07-58S, 080-29E)	TurboMAP (#036-1; 300m)
	2026/1526	(07-58S, 080-29E)	TurboMAP (#036-2; 300m)
	2048/1548	(07-59S, 080-29E)	Sea skater collection (#005-1)
	2108/1608	(08-00S, 080-29E)	Sea skater collection (#005-2)
	2128/1628	(08-00S, 080-30E)	Sea skater collection (#005-3)
	2230/1730	(07-59S, 080-29E)	Radiosonde (#063)
	2237/1737	(07-59S, 080-29E)	CTD (#039; 500m), With sampling seawater
	2324/1824	(07-59S, 080-29E)	TurboMAP (#037-1; 300m)
	2343/1843	(07-59S, 080-29E)	TurboMAP (#037-2; 300m)
5	0002/1902		Flux (#034)
	0131/2031	(07-59S, 080-30E)	Radiosonde (#064)
	0136/2036	(07-57S, 080-29E)	CTD (#040; 500m)
	0222/2122	(07-59S, 080-29E)	TurboMAP (#038-1; 300m)
	0241/2141	(07-59S, 080-29E)	TurboMAP (#038-2; 300m)
	0300/2200		Flux (#035)
	0429/2329	(07-59S, 080-30E)	Radiosonde (#065)
	0433/2329	(07-59S, 080-30E)	CTD (#041; 500m), With sampling seawater
	0524/0024	(07-59S, 080-29E)	TurboMAP (#039-1; 300m)
	0547/0047	(07-59S, 080-29E)	TurboMAP (#039-2; 300m)
	0607/0107		Flux (#036)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#066)
	0737/0237	(07-59S, 080-29E)	CTD (#042; 500m)
	0810/0310	(07-59S, 080-29E)	TurboMAP (#040-1; 300m)
	0830/0330	(07-59S, 080-29E)	TurboMAP (#040-2; 300m)
	0855/0355		Flux (#037)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#067)
	1035/0535	(08-00S, 080-30E)	CTD (#043; 1000m), With sampling seawater
	1139/0639	(08-00S, 080-29E)	TurboMAP (#041-1; 300m)
	1159/0659	(07-59S, 080-29E)	TurboMAP (#041-2; 300m)
	1220/0720		Flux (#038)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#068)
	1335/0835	(08-00S, 080-29E)	CTD (#044; 500m)
	1408/0908	(07-59S, 080-29E)	TurboMAP (#042-1; 300m)
	1428/0928	(07-59S, 080-29E)	TurboMAP (#042-2; 300m)
	1450/0950		Flux (#039)
	1630/1130	(08-00S, 080-29E)	Radiosonde (#069)
	1636/1136	(07-59S, 080-29E)	CTD (#045; 500m),With sampling seawater
	1725/1225	(07-59S, 080-29E)	TurboMAP (#043-1; 300m)
	1743/1243	(07-59S, 080-28E)	TurboMAP (#043-2; 300m)
	1815/1315		Flux (#040)
	1930/1430	(08-00S, 080-29E)	Radiosonde (#070)
	1937/1437	(08-00S, 080-29E)	CTD (#046; 500m)
	2013/1513	(08-00S, 080-29E)	TurboMAP (#044-1; 300m)
	2029/1529	(08-00S, 080-28E)	TurboMAP (#044-2; 300m)
	2108/1608	(08-00S, 080-29E)	CFH Radiosonde (#01)
	2110/1610		Flux (#041)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#071)
	2237/1737	(08-00S, 080-29E)	CTD (#047; 500m),With sampling seawater
	2323/1823	(08-00S, 080-29E)	TurboMAP (#045-1; 300m)
	2345/1845	(08-00S, 080-29E)	TurboMAP (#045-2; 300m)
6	0005/1905		Flux (#042)
	0130/2030	(08-00S, 080-29E)	Radiosonde (#072)
	0135/2035	(08-00S, 080-29E)	CTD (#048; 500m)

	0211/2111	(08-00S, 080-29E)	TurboMAP (#046-1; 300m)
	0229/2129	(08-00S, 080-29E)	TurboMAP (#046-2; 300m)
	0246/2146		Flux (#043)
	0430/2330	(07-59S, 080-29E)	Radiosonde (#073)
	0436/2336	(07-59S, 080-29E)	CTD (#049; 500m) ,With sampling seawater
	0526/0026	(07-59S, 080-29E)	TurboMAP (#047-1; 300m)
	0543/0043	(07-59S, 080-29E)	TurboMAP (#047-2; 300m)
	0607/0107		Flux (#044)
	0731/0231	(08-00S, 080-30E)	Radiosonde (#074)
	0736/0236	(08-00S, 080-29E)	CTD (#050; 500m)
	0810/0310	(08-00S, 080-29E)	TurboMAP (#048-1; 300m)
	0829/0329	(08-00S, 080-29E)	TurboMAP (#048-2; 300m)
	0848/0348		Flux (#045)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#075)
	1036/0536	(08-00S, 080-30E)	CTD (#051; 1000m) ,With sampling seawater
	1142/0642	(08-00S, 080-29E)	TurboMAP (#049-1; 300m)
	1202/0702	(08-00S, 080-29E)	TurboMAP (#049-2; 300m)
	1222/0722		Flux (#046)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#076)
	1336/0830	(08-00S, 080-30E)	CTD (#052; 500m)
	1408/0908	(08-00S, 080-29E)	TurboMAP (#050-1; 300m)
	1431/0931	(08-00S, 080-29E)	TurboMAP (#050-2; 300m)
	1455/0955		Flux (#047)
	1630/1130	(07-59S, 080-29E)	Radiosonde (#077)
	1635/1135	(07-59S, 080-29E)	CTD (#053; 500m) ,With sampling seawater
	1729/1229	(07-59S, 080-29E)	TurboMAP (#051-1; 300m)
	1744/1244	(07-59S, 080-29E)	TurboMAP (#051-2; 300m)
	1810/1310		Flux (#048)
	1930/1430	(07-59S, 080-29E)	Radiosonde (#078)
	1937/1437	(07-59S, 080-29E)	CTD (#054; 500m)
	2010/1510	(07-59S, 080-29E)	TurboMAP (#052-1; 300m)
	2027/1527	(07-59S, 080-29E)	TurboMAP (#052-2; 300m)
	2052/1552	(07-59S, 080-28E)	Sea skater collection (#006-1)
	2111/1611	(08-00S, 080-29E)	Sea skater collection (#006-2)
	2131/1631	(08-00S, 080-29E)	Sea skater collection (#006-3)
	2150/1650		Flux (#049)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#079)
	2237/1737	(08-00S, 080-29E)	CTD (#055; 500m),With sampling seawater
	2321/1821	(08-00S, 080-29E)	TurboMAP (#053-1; 300m)
	2342/1842	(08-00S, 080-29E)	TurboMAP (#053-2; 300m)
7	0001/1901		Flux (#050)
	0130/2030	(08-00S, 080-29E)	Radiosonde (#080)
	0136/2036	(08-00S, 080-29E)	CTD (#056; 500m)
	0210/2110	(08-00S, 080-29E)	TurboMAP (#054-1; 300m)
	0229/2129	(08-00S, 080-29E)	TurboMAP (#054-2; 300m)
	0250/2150		Flux (#051)
	0430/2330	(07-59S, 080-30E)	Radiosonde (#081)
	0435/2335	(07-59S, 080-30E)	CTD (#057; 500m),With sampling seawater
	0526/0026	(07-59S, 080-30E)	TurboMAP (#055-1; 300m)
	0543/0043	(07-59S, 080-30E)	TurboMAP (#055-2; 300m)
	0605/0105		Flux (#052)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#082)
	0736/0236	(08-00S, 080-30E)	CTD (#058; 500m)
	0803/0303	(07-59S, 080-30E)	TurboMAP (#056-1; 300m)
	0826/0326	(07-59S, 080-30E)	TurboMAP (#056-2; 300m)
	0845/0345		Flux (#053)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#083)
	1035/0535	(08-00S, 080-30E)	CTD (#059; 1000m),With sampling seawater
	1132/0632	(08-00S, 080-29E)	TurboMAP (#057-1; 300m)
	1159/0659	(08-00S, 080-29E)	TurboMAP (#057-2; 300m)
	1220/0720		Flux (#054)

	1330/0830	(08-00S, 080-29E)	Radiosonde (#084)
	1336/0836	(08-00S, 080-29E)	CTD (#060; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#058-1; 300m)
	1430/0930	(08-00S, 080-30E)	TurboMAP (#058-2; 300m)
	1452/0952		Flux (#055)
	1630/1130	(08-00S, 080-29E)	Radiosonde (#085)
	1635/1135	(08-00S, 080-30E)	CTD (#061; 500m),With sampling seawater
	1720/1220	(08-00S, 080-30E)	TurboMAP (#059-1; 300m)
	1740/1240	(07-59S, 080-30E)	TurboMAP (#059-2; 300m)
	1802/1302		Flux (#056)
	1930/1430	(07-59S, 080-29E)	Radiosonde (#086)
	1935/1435	(07-59S, 080-29E)	CTD (#062; 500m)
	2008/1508	(07-58S, 080-29E)	TurboMAP (#060-1; 300m)
	2025/1525	(07-58S, 080-29E)	TurboMAP (#060-2; 300m)
	2049/1549	(07-59S, 080-28E)	Sea skater collection (#007-1)
	2108/1608	(07-59S, 080-29E)	Sea skater collection (#007-2)
	2128/1628	(08-00S, 080-30E)	Sea skater collection (#007-3)
	2146/1646		Flux (#057)
	2230/1730	(07-59S, 080-30E)	Radiosonde (#087)
	2236/1736	(07-59S, 080-30E)	CTD (#063; 500m),With sampling seawater
	2322/1822	(07-59S, 080-29E)	TurboMAP (#061-1; 300m)
	2341/1841	(07-59S, 080-29E)	TurboMAP (#061-2; 300m)
8	0005/1905		Flux (#058)
	0122/2022	(08-00S, 080-30E)	Radiosonde (#088)
	0126/2026	(08-00S, 080-30E)	CTD (#064; 500m)
	0201/2101	(07-59S, 080-30E)	TurboMAP (#062-1; 300m)
	0219/2119	(07-59S, 080-30E)	TurboMAP (#062-2; 300m)
	0230/2130		Flux (#059)
	0432/2332	(07-59S, 080-30E)	Radiosonde (#089)
	0436/2336	(07-59S, 080-30E)	CTD (#065; 500m),With sampling seawater
	0525/0025	(07-59S, 080-30E)	TurboMAP (#063-1; 300m)
	0544/0044	(07-59S, 080-30E)	TurboMAP (#063-2; 300m)
	0605/0105		Flux (#060)
	0731/0231	(08-00S, 080-30E)	Radiosonde (#090)
	0734/0234	(08-00S, 080-30E)	CTD (#066; 500m)
	0807/0307	(08-00S, 080-30E)	TurboMAP (#064-1; 300m)
	0822/0322	(07-59S, 080-30E)	TurboMAP (#064-2; 300m)
	0856/0356		Flux (#061)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#091)
	1037/0537	(07-59S, 080-30E)	CTD (#067; 1000m),With sampling seawater
	1139/0639	(07-59S, 080-30E)	TurboMAP (#065-1; 300m)
	1158/0658	(07-59S, 080-30E)	TurboMAP (#065-2; 300m)
	1220/0720		Flux (#062)
	1330/0830	(08-00S, 080-29E)	Radiosonde (#092)
	1335/0835	(08-00S, 080-29E)	CTD (#068; 500m)
	1407/0907	(07-59S, 080-29E)	TurboMAP (#066-1; 300m)
	1426/0926	(07-59S, 080-29E)	TurboMAP (#066-2; 300m)
	1525/1025		Flux (#063)
	1630/1130	(08-00S, 080-29E)	Radiosonde (#093)
	1635/1135	(07-59S, 080-29E)	CTD (#069; 500m),With sampling seawater
	1721/1221	(07-50S, 080-29E)	TurboMAP (#067-1; 300m)
	1739/1239	(07-59S, 080-29E)	TurboMAP (#067-2; 300m)
	1703/1203		Flux (#064)
	1930/1430	(08-00S, 080-29E)	Radiosonde (#094)
	1935/1435	(07-59S, 080-29E)	CTD (#070; 500m)
	2007/1507	(07-59S, 080-30E)	TurboMAP (#068-1; 300m)
	2025/1525	(07-59S, 080-30E)	TurboMAP (#068-2; 300m)
	2046/1546		Flux (#065)
	2235/1735	(07-59S, 080-29E)	Radiosonde (#095)
	2241/1741	(07-59S, 080-29E)	CTD (#071; 500m),With sampling seawater
	2328/1828	(07-59S, 080-30E)	TurboMAP (#069-1; 300m)

	2344/1844	(07-59S, 080-30E)	TurboMAP (#069-2; 300m)
9	0006/1906		Flux (#066)
	0130/2030	(07-59S, 080-29E)	Radiosonde (#096)
	0136/2036	(07-59S, 080-29E)	CTD (#072; 500m)
	0209/2109	(07-59S, 080-29E)	TurboMAP (#070-1; 300m)
	0226/2126	(07-59S, 080-29E)	TurboMAP (#070-2; 300m)
	0248/2148		Flux (#067)
	0430/2330	(07-59S, 080-29E)	Radiosonde (#097)
	0435/2335	(07-59S, 080-29E)	CTD (#073; 500m),With sampling seawater
	0522/0022	(07-59S, 080-29E)	TurboMAP (#071-1; 300m)
	0540/0040	(07-59S, 080-29E)	TurboMAP (#071-2; 300m)
	0600/0100		Flux (#068)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#098)
	0735/0235	(08-00S, 080-30E)	CTD (#074; 500m)
	0807/0307	(07-59S, 080-29E)	TurboMAP (#072-1; 300m)
	0826/0326	(07-59S, 080-29E)	TurboMAP (#072-2; 300m)
	0847/0347		Flux (#069)
	1030/0530	(08-00S, 080-29E)	Radiosonde (#099)
	1036/0536	(08-00S, 080-29E)	CTD (#075; 1000m),With sampling seawater
	1137/0637	(08-00S, 080-29E)	TurboMAP (#073-1; 300m)
	1156/0656	(08-00S, 080-29E)	TurboMAP (#073-2; 300m)
	1215/0715		Flux (#070)
	1330/0830	(08-00S, 080-29E)	Radiosonde (#100)
	1335/0835	(08-00S, 080-29E)	CTD (#076; 500m)
	1408/0908	(08-00S, 080-29E)	TurboMAP (#074-1; 300m)
	1427/0927	(08-00S, 080-29E)	TurboMAP (#074-2; 300m)
	1448/0948		Flux (#071)
	1630/1130	(08-00S, 080-29E)	Radiosonde (#101)
	1635/1135	(08-00S, 080-29E)	CTD (#077; 500m),With sampling seawater
	1720/1220	(07-59S, 080-29E)	TurboMAP (#075-1; 300m)
	1739/1239	(07-59S, 080-29E)	TurboMAP (#075-2; 300m)
	1800/1300		Flux (#072)
	1930/1430	(07-59S, 080-28E)	Radiosonde (#102)
	1936/1436	(07-59S, 080-28E)	CTD (#078; 500m)
	2008/1508	(07-59S, 080-28E)	TurboMAP (#076-1; 300m)
	2025/1525	(07-59S, 080-28E)	TurboMAP (#076-2; 300m)
	2049/1549	(07-59S, 080-28E)	Sea skater collection (#008-1)
	2107/1607	(07-59S, 080-29E)	Sea skater collection (#008-2)
	2127/1627	(08-00S, 080-29E)	Sea skater collection (#008-3)
	2145/1645		Flux (#073)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#103)
	2235/1730	(08-00S, 080-29E)	CTD (#079; 500m),With sampling seawater
	2321/1821	(08-00S, 080-29E)	TurboMAP (#077-1; 300m)
	2341/1841	(07-59S, 080-29E)	TurboMAP (#077-2; 300m)
10	0002/1902		Flux (#074)
	0133/2033	(08-00S, 080-29E)	Radiosonde (#104)
	0141/2041	(08-00S, 080-29E)	CTD (#080; 500m)
	0215/2115	(08-00S, 080-29E)	TurboMAP (#078-1; 300m)
	0232/2132	(08-00S, 080-29E)	TurboMAP (#078-2; 300m)
	0250/2150		Flux (#075)
	0430/2330	(07-59S, 080-30E)	Radiosonde (#105)
	0436/2336	(07-59S, 080-29E)	CTD (#081; 500m),With sampling seawater
	0523/0023	(07-59S, 080-29E)	TurboMAP (#079-1; 300m)
	0541/0041	(07-59S, 080-29E)	TurboMAP (#079-2; 300m)
	0602/0102		Flux (#076)
	0742/0242	(08-00S, 080-29E)	Radiosonde (#106)
	0750/0250	(07-59S, 080-29E)	CTD (#082; 500m)
	0825/0325	(07-59S, 080-29E)	TurboMAP (#080-1; 300m)
	0843/0343	(07-59S, 080-29E)	TurboMAP (#080-2; 300m)
	0908/0408		Flux (#077)
	1039/0539	(08-00S, 080-29E)	Radiosonde (#107)

	1044/0544	(08-00S, 080-29E)	CTD (#083; 1000m),With sampling seawater
	1149/0649	(08-00S, 080-29E)	TurboMAP (#081-1; 300m)
	1207/0707	(08-00S, 080-29E)	TurboMAP (#081-2; 300m)
	1226/0726		Flux (#078)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#108)
	1336/0836	(08-10S, 080-30E)	CTD (#084; 500m)
	1408/0908	(07-59S, 080-30E)	TurboMAP (#082-1; 300m)
	1429/0929	(07-59S, 080-30E)	TurboMAP (#082-2; 300m)
	1452/0952		Flux (#079)
	1630/1130	(08-00S, 080-29E)	Radiosonde (#109)
	1636/1136	(08-00S, 080-29E)	CTD (#085; 500m),With sampling seawater
	1721/1221	(07-59S, 080-29E)	TurboMAP (#083-1; 300m)
	1742/1242	(07-59S, 080-29E)	TurboMAP (#083-2; 300m)
	1805/1305		Flux (#080)
	1930/1430	(07-59S, 080-28E)	Radiosonde (#110)
	1938/1438	(07-59S, 080-28E)	CTD (#086; 500m)
	2009/1509	(07-59S, 080-28E)	TurboMAP (#084-1; 300m)
	2027/1527	(07-59S, 080-28E)	TurboMAP (#084-2; 300m)
	2051/1551	(07-59S, 080-28E)	Sea skater collection (#09-1)
	2109/1609	(07-59S, 080-28E)	Sea skater collection (#09-2)
	2129/1629	(08-00S, 080-29E)	Sea skater collection (#09-3)
	2231/1731	(07-59S, 080-29E)	Radiosonde (#111)
	2237/1737	(07-59S, 080-29E)	CTD (#087; 500m),With sampling seawater
	2322/1822	(07-59S, 080-29E)	TurboMAP (#085-1; 300m)
	2348/1848	(07-59S, 080-29E)	TurboMAP (#085-2; 300m)
11	0010/1910		Flux (#081)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#112)
	0136/2036	(08-00S, 080-29E)	CTD (#088; 500m)
	0211/2111	(08-00S, 080-29E)	TurboMAP (#086-1; 300m)
	0228/2128	(08-00S, 080-29E)	TurboMAP (#086-2; 300m)
	0247/2147		Flux (#082)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#113)
	0437/2337	(08-00S, 080-29E)	CTD (#089; 500m),With sampling seawater
	0525/0025	(08-00S, 080-29E)	TurboMAP (#087-1; 300m)
	0542/0042	(08-00S, 080-29E)	TurboMAP (#087-2; 300m)
	0600/0100		Flux (#083)
	0731/0231	(07-59S, 080-30E)	Radiosonde (#114)
	0738/0238	(07-59S, 080-30E)	CTD (#090; 500m)
	0812/0312	(07-59S, 080-30E)	TurboMAP (#088; 300m)
	0842/0342		Flux (#084)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#115)
	1036/0536	(08-00S, 080-30E)	CTD (#091; 1000m),With sampling seawater
	1137/0637	(07-59S, 080-30E)	TurboMAP (#089; 300m)
	1219/0719		Flux (#085)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#116)
	1337/0837	(08-00S, 080-30E)	CTD (#092; 500m)
	1406/0906		Flux (#086)
	1630/1130	(07-59S, 080-29E)	Radiosonde (#117)
	1636/1136	(08-00S, 080-29E)	CTD (#093; 500m),With sampling seawater
	1728/1228	(07-59S, 080-29E)	TurboMAP (#090-1; 300m)
	1756/1256	(07-59S, 080-29E)	TurboMAP (#090-2; 300m)
	1823/1323		Flux (#087)
	1930/1430	(07-59S, 080-29E)	Radiosonde (#118)
	1938/1438	(07-59S, 080-29E)	CTD (#094; 500m)
	2012/1512	(08-00S, 080-29E)	TurboMAP (#091-1; 300m)
	2032/1532	(07-59S, 080-29E)	TurboMAP (#091-2; 300m)
	2053/1553		Flux (#088)
	2230/1730	(07-59S, 080-29E)	Radiosonde (#119)
	2235/1735	(07-59S, 080-29E)	CTD (#095; 500m),With sampling seawater
	2324/1824	(07-59S, 080-29E)	TurboMAP (#092-1; 300m)
	2343/1843	(07-59S, 080-29E)	TurboMAP (#092-2; 300m)

12	0005/1905		Flux (#089)
	0130/2030	(08-00S, 080-29E)	Radiosonde (#120)
	0135/2035	(08-00S, 080-29E)	CTD (#096; 500m)
	0208/2108	(08-00S, 080-29E)	TurboMAP (#093-1; 300m)
	0225/2125	(07-59S, 080-29E)	TurboMAP (#093-2; 300m)
	0245/2145		Flux (#090)
	0430/2330	(08-00S, 080-29E)	Radiosonde (#121)
	0437/2337	(08-00S, 080-29E)	CTD (#097; 500m),With sampling seawater
	0528/0028	(08-00S, 080-29E)	TurboMAP (#094-1; 300m)
	0546/0046	(07-59S, 080-29E)	TurboMAP (#094-2; 300m)
	0608/0108		Flux (#091)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#122)
	0736/0236	(08-00S, 080-29E)	CTD (#098; 500m)
	0810/0310	(07-59S, 080-29E)	TurboMAP (#095-1; 300m)
	0829/0329	(07-59S, 080-29E)	TurboMAP (#095-2; 300m)
	0852/0352		Flux (#092)
	1030/0530	(08-00S, 080-29E)	Radiosonde (#123)
	1034/0534	(08-00S, 080-29E)	CTD (#099; 1000m),With sampling seawater
	1136/0636	(07-59S, 080-29E)	TurboMAP (#096-1; 300m)
	1155/0655	(07-59S, 080-29E)	TurboMAP (#096-2; 300m)
	1217/0717		Flux (#093)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#124)
	1336/0836	(08-00S, 080-30E)	CTD (#100; 500m)
	1408/0908	(08-00S, 080-30E)	TurboMAP (#097-1; 300m)
	1428/0928	(07-59S, 080-30E)	TurboMAP (#097-2; 300m)
	1450/0950		Flux (#094)
	1630/1130	(08-00S, 080-29E)	Radiosonde (#125)
	1635/1135	(08-00S, 080-29E)	CTD (#101; 500m),With sampling seawater
	1722/1222	(07-59S, 080-29E)	TurboMAP (#098-1; 300m)
	1741/1241	(07-59S, 080-29E)	TurboMAP (#098-2; 300m)
	1805/1305		Flux (#095)
	1930/1430	(07-58S, 080-29E)	Radiosonde (#126)
	1936/1430	(07-58S, 080-29E)	CTD (#102; 500m)
	2009/1509	(07-58S, 080-29E)	TurboMAP (#099-1; 300m)
	2028/1528	(07-58S, 080-29E)	TurboMAP (#099-2; 300m)
	2053/1553	(07-58S, 080-28E)	Sea skater collection (#10-1)
	2112/1612	(07-59S, 080-28E)	Sea skater collection (#10-2)
	2133/1633	(08-00S, 080-29E)	Sea skater collection (#10-3)
	2151/1651		Flux (#096)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#127)
	2236/1736	(08-00S, 080-29E)	CTD (#103; 500m),With sampling seawater
	2321/1821	(07-59S, 080-29E)	TurboMAP (#100-1; 300m)
	2340/1840	(07-59S, 080-29E)	TurboMAP (#100-2; 300m)
13	0001/1901		Flux (#097)
	0130/2030	(07-59S, 080-30E)	Radiosonde (#128)
	0135/2035	(08-00S, 080-29E)	CTD (#104; 500m)
	0208/2108	(07-59S, 080-29E)	TurboMAP (#101-1; 300m)
	0225/2125	(07-59S, 080-29E)	TurboMAP (#101-2; 300m)
	0245/2145		Flux (#098)
	0430/2330	(07-59S, 080-30E)	Radiosonde (#129)
	0437/2337	(08-00S, 080-29E)	CTD (#105; 500m),With sampling seawater
	0528/0028	(07-59S, 080-29E)	TurboMAP (#102-1; 300m)
	0546/0046	(07-59S, 080-29E)	TurboMAP (#102-2; 300m)
	0607/0107		Flux (#099)
	0730/0230	(07-59S, 080-30E)	Radiosonde (#130)
	0736/0236	(07-59S, 080-30E)	CTD (#106; 500m)
	0810/0310	(07-59S, 080-29E)	TurboMAP (#103-1; 300m)
	0829/0329	(07-59S, 080-29E)	TurboMAP (#103-2; 300m)
	0850/0350		Flux (#100)
	1030/0530	(08-00S, 080-29E)	Radiosonde (#131)
	1035/0535	(08-00S, 080-29E)	CTD (#107; 1000m),With sampling seawater

	1136/0636	(07-59S, 080-29E)	TurboMAP (#104-1; 300m)
	1156/0656	(07-59S, 080-29E)	TurboMAP (#104-2; 300m)
	1217/0717		Flux (#101)
	1330/0830	(07-59S, 080-29E)	Radiosonde (#132)
	1336/0836	(07-59S, 080-29E)	CTD (#108; 500m)
	1407/0907	(07-59S, 080-29E)	TurboMAP (#105-1; 300m)
	1427/0927	(07-59S, 080-29E)	TurboMAP (#105-2; 300m)
	1450/0950		Flux (#102)
	1643/1143	(08-00S, 080-29E)	Radiosonde (#133)
	1647/1147	(08-00S, 080-29E)	CTD (#109; 500m),With sampling seawater
	1735/1235	(08-00S, 080-29E)	TurboMAP (#106-1; 300m)
	1753/1253	(08-00S, 080-29E)	TurboMAP (#106-2; 300m)
	1815/1315		Flux (#103)
	1930/1430	(07-59S, 080-28E)	Radiosonde (#134)
	1936/1436	(07-59S, 080-28E)	CTD (#110; 500m)
	2009/1509	(07-59S, 080-28E)	TurboMAP (#107-1; 300m)
	2027/1527	(07-59S, 080-28E)	TurboMAP (#107-2; 300m)
	2052/1552	(07-59S, 080-28E)	Sea skater collection (#11-1)
	2112/1612	(08-00S, 080-29E)	Sea skater collection (#11-2)
	2132/1632	(08-00S, 080-29E)	Sea skater collection (#11-3)
	2151/1651		Flux (#104)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#135)
	2237/1737	(08-00S, 080-29E)	CTD (#111; 500m),With sampling seawater
	2323/1823	(08-00S, 080-29E)	TurboMAP (#108-1; 300m)
	2340/1840	(08-00S, 080-29E)	TurboMAP (#108-2; 300m)
14	0002/1902		Flux (#105)
	0130/2030	(08-00S, 080-29E)	Radiosonde (#136)
	0135/2035	(08-00S, 080-29E)	CTD (#112; 500m)
	0228/2128	(08-00S, 080-29E)	TurboMAP (#109-1; 300m)
	0224/2124	(08-00S, 080-29E)	TurboMAP (#109-2; 300m)
	0245/2145		Flux (#106)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#137)
	0436/2336	(08-00S, 080-30E)	CTD (#113; 500m),With sampling seawater
	0526/0026	(08-00S, 080-29E)	TurboMAP (#110-1; 300m)
	0546/0046	(07-59S, 080-29E)	TurboMAP (#110-2; 300m)
	0610/0110		Flux (#107)
	0730/0230	(08-00S, 080-29E)	Radiosonde (#138)
	0736/0236	(08-00S, 080-29E)	CTD (#114; 500m)
	0813/0313	(08-00S, 080-29E)	TurboMAP (#111-1; 300m)
	0832/0332	(08-00S, 080-29E)	TurboMAP (#111-2; 300m)
	0855/0355		Flux (#108)
	1030/0530	(08-00S, 080-29E)	Radiosonde (#139)
	1035/0535	(08-00S, 080-29E)	CTD (#115; 1000m),With sampling seawater
	1137/0637	(08-00S, 080-29E)	TurboMAP (#112-1; 300m)
	1156/0656	(08-00S, 080-29E)	TurboMAP (#112-2; 300m)
	1215/0715		Flux (#109)
	1330/0830	(07-59S, 080-30E)	Radiosonde (#140)
	1335/0835	(08-00S, 080-30E)	CTD (#116; 500m)
	1407/0907	(07-59S, 080-30E)	TurboMAP (#113-1; 300m)
	1425/0925	(07-59S, 080-30E)	TurboMAP (#113-2; 300m)
	1630/1130	(07-59S, 080-30E)	Radiosonde (#141)
	1635/1135	(08-00S, 080-30E)	CTD (#117; 500m),With sampling seawater
	1722/1222	(08-00S, 080-29E)	TurboMAP (#114-1; 300m)
	1739/1239	(08-00S, 080-29E)	TurboMAP (#114-2; 300m)
	1802/1302		Flux (#110)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#142)
	1935/1435	(08-00S, 080-30E)	CTD (#118; 500m)
	2010/1510	(08-00S, 080-30E)	TurboMAP (#115-1; 300m)
	2027/1527	(08-00S, 080-29E)	TurboMAP (#115-2; 300m)
	2050/1550		Flux (#111)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#143)

	2236/1736	(08-00S, 080-30E)	CTD (#119; 500m),With sampling seawater
	2320/1820	(08-00S, 080-30E)	TurboMAP (#116-1; 300m)
	2339/1839	(08-00S, 080-29E)	TurboMAP (#116-2; 300m)
15	0001/1901		Flux (#112)
	0130/2030	(07-59S, 080-30E)	Radiosonde (#144)
	0135/2035	(07-59S, 080-30E)	CTD (#120; 500m)
	0208/2108	(07-59S, 080-30E)	TurboMAP (#117-1; 300m)
	0224/2124	(07-59S, 080-30E)	TurboMAP (#117-2; 300m)
	0245/2145		Flux (#113)
	0430/2330	(07-59S, 080-30E)	Radiosonde (#145)
	0437/2337	(07-59S, 080-30E)	CTD (#121; 500m),With sampling seawater
	0527/0027	(08-00S, 080-29E)	TurboMAP (#118-1; 300m)
	0545/0045	(07-59S, 080-29E)	TurboMAP (#118-2; 300m)
	0608/0108		Flux (#114)
	0730/0230	(07-59S, 080-30E)	Radiosonde (#146)
	0736/0236	(07-59S, 080-30E)	CTD (#122; 500m)
	0810/0310	(07-59S, 080-30E)	TurboMAP (#119-1; 300m)
	0830/0330	(07-59S, 080-30E)	TurboMAP (#119-2; 300m)
	0857/0357		Flux (#115)
	1030/0500	(08-00S, 080-30E)	Radiosonde (#147)
	1035/0535	(08-00S, 080-30E)	CTD (#123; 1000m),With sampling seawater
	1136/0636	(07-59S, 080-30E)	TurboMAP (#120-1; 300m)
	1155/0655	(07-59S, 080-29E)	TurboMAP (#120-2; 300m)
	1217/0717		Flux (#116)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#148)
	1336/0836	(08-00S, 080-29E)	CTD (#124; 500m)
	1408/0908	(07-59S, 080-29E)	TurboMAP (#121-1; 300m)
	1427/0927	(07-59S, 080-29E)	TurboMAP (#121-2; 300m)
	1448/0948		Flux (#117)
	1630/1130	(08-00S, 080-29E)	Radiosonde (#149)
	1635/1135	(08-00S, 080-29E)	CTD (#125; 500m),With sampling seawater
	1724/1224	(07-59S, 080-29E)	TurboMAP (#122-1; 300m)
	1743/1243	(07-59S, 080-29E)	TurboMAP (#122-2; 300m)
	1806/1306		Flux (#118)
	1930/1430	(07-59S, 080-29E)	Radiosonde (#150)
	1936/1436	(07-59S, 080-29E)	CTD (#126; 500m)
	2009/1509	(07-59S, 080-29E)	TurboMAP (#123-1; 300m)
	2025/1525	(07-59S, 080-29E)	TurboMAP (#123-2; 300m)
	2047/1547	(07-59S, 080-29E)	Sea skater collection (#12-1)
	2109/1609	(08-00S, 080-29E)	Sea skater collection (#12-2)
	2128/1628	(08-00S, 080-29E)	Sea skater collection (#12-3)
	2147/1647		Flux (#119)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#151)
	2235/1735	(08-00S, 080-29E)	CTD (#127; 500m),With sampling seawater
	2319/1819	(08-00S, 080-29E)	TurboMAP (#124-1; 300m)
	2338/1838	(08-00S, 080-29E)	TurboMAP (#124-2; 300m)
16	0000/1900		Flux (#120)
	0130/2030	(07-59S, 080-30E)	Radiosonde (#152)
	0135/2035	(07-59S, 080-30E)	CTD (#128; 500m)
	0207/2107	(07-59S, 080-29E)	TurboMAP (#125-1; 300m)
	0224/2124	(07-59S, 080-29E)	TurboMAP (#125-2; 300m)
	0245/2145		Flux (#121)
	0430/2330	(07-59S, 080-30E)	Radiosonde (#153)
	0435/2335	(08-00S, 080-29E)	CTD (#129; 500m),With sampling seawater
	0525/0025	(07-59S, 080-29E)	TurboMAP (#126-1; 300m)
	0544/0044	(07-59S, 080-29E)	TurboMAP (#126-2; 300m)
	0606/0106		Flux (#122)
	0730/0230	(07-59S, 080-30E)	Radiosonde (#154)
	0736/0236	(07-59S, 080-30E)	CTD (#130; 500m)
	0808/0308	(07-59S, 080-30E)	TurboMAP (#127-1; 300m)
	0829/0329	(07-59S, 080-30E)	TurboMAP (#127-2; 300m)

	0851/0351		Flux (#123)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#155)
	1034/0534	(08-00S, 080-30E)	CTD (#131; 1000m),With sampling seawater
	1135/0635	(07-59S, 080-29E)	TurboMAP (#128-1; 200m)
	1147/0647	(07-59S, 080-29E)	TurboMAP (#128-2; 200m)
	1159/0659	(07-59S, 080-29E)	TurboMAP (#128-3; 200m)
	1215/0715		Flux (#124)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#156)
	1335/0835	(08-00S, 080-30E)	CTD (#132; 500m)
	1413/0913	(07-59S, 080-30E)	TurboMAP (#129-1; 200m)
	1427/0927	(07-59S, 080-29E)	TurboMAP (#129-2; 200m)
	1440/0940	(07-59S, 080-29E)	TurboMAP (#129-3; 200m)
	1500/1000		Flux (#125)
	1630/1130	(07-59S, 080-30E)	Radiosonde (#157)
	1634/1134	(07-59S, 080-29E)	CTD (#133; 500m),With sampling seawater
	1719/1219	(07-59S, 080-29E)	TurboMAP (#130-1; 200m)
	1732/1232	(07-59S, 080-29E)	TurboMAP (#130-2; 200m)
	1755/1255	(07-59S, 080-29E)	TurboMAP (#130-3; 200m)
	1800/1300		Flux (#126)
	1930/1430	(07-58S, 080-29E)	Radiosonde (#158)
	1935/1435	(07-59S, 080-29E)	CTD (#134; 500m)
	2008/1508	(07-58S, 080-29E)	TurboMAP (#131-1; 200m)
	2020/1520	(07-58S, 080-29E)	TurboMAP (#131-2; 200m)
	2032/1532	(07-59S, 080-28E)	TurboMAP (#131-3; 200m)
	2054/1554	(07-59S, 080-29E)	Sea skater collection (#13-1)
	2114/1614	(07-59S, 080-29E)	Sea skater collection (#13-2)
	2134/1634	(08-00S, 080-29E)	Sea skater collection (#13-3)
	2153/1653		Flux (#127)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#159)
	2235/1735	(08-00S, 080-29E)	CTD (#135; 500m),With sampling seawater
	2320/1820	(08-00S, 080-29E)	TurboMAP (#132-1; 200m)
	2333/1833	(08-00S, 080-29E)	TurboMAP (#132-2; 200m)
	2343/1843	(08-00S, 080-29E)	TurboMAP (#132-3; 200m)
17	0001/1901		Flux (#128)
	0130/2030	(08-00S, 080-29E)	Radiosonde (#160)
	0135/2035	(08-00S, 080-29E)	CTD (#136; 500m)
	0206/2106	(08-00S, 080-29E)	TurboMAP (#133-1; 200m)
	0219/2119	(08-00S, 080-29E)	TurboMAP (#133-2; 200m)
	0231/2131	(08-00S, 080-29E)	TurboMAP (#133-3; 200m)
	0246/2146		Flux (#129)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#161)
	0436/2336	(08-00S, 080-29E)	CTD (#137; 500m),With sampling seawater
	0525/0025	(07-59S, 080-29E)	TurboMAP (#134-1; 200m)
	0538/0038	(07-59S, 080-29E)	TurboMAP (#134-2; 200m)
	0548/0048	(07-59S, 080-29E)	TurboMAP (#134-3; 200m)
	0604/0104		Flux (#130)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#162)
	0737/0237	(08-00S, 080-29E)	CTD (#138; 500m)
	0810/0310	(07-59S, 080-29E)	TurboMAP (#135-1; 200m)
	0827/0327	(07-59S, 080-29E)	TurboMAP (#135-2; 200m)
	0839/0339	(07-59S, 080-29E)	TurboMAP (#135-3; 200m)
	0856/0356		Flux (#131)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#163)
	1034/0534	(08-00S, 080-29E)	CTD (#139; 1000m),With sampling seawater
	1137/0637	(08-00S, 080-29E)	TurboMAP (#136-1; 200m)
	1150/0650	(08-00S, 080-29E)	TurboMAP (#136-2; 200m)
	1202/0702	(08-00S, 080-29E)	TurboMAP (#136-3; 200m)
	1216/0716		Flux (#132)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#164)
	1335/0835	(08-00S, 080-29E)	CTD (#140; 500m)
	1406/0906	(08-00S, 080-29E)	TurboMAP (#137-1; 200m)

	1421/0921	(08-00S, 080-29E)	TurboMAP (#137-2; 200m)
	1433/0933	(07-59S, 080-29E)	TurboMAP (#137-3; 200m)
	1448/0948		Flux (#133)
	1650/1150	(08-00S, 080-29E)	Radiosonde (#165)
	1656/1156	(08-00S, 080-29E)	CTD (#141; 500m),With sampling seawater
	1741/1241	(08-00S, 080-29E)	TurboMAP (#138-1; 300m)
	1800/1300	(08-00S, 080-29E)	TurboMAP (#138-2; 300m)
	1822/1322		Flux (#134)
	1930/1430	(07-59S, 080-30E)	Radiosonde (#166)
	1937/1437	(07-59S, 080-29E)	CTD (#142; 500m)
	2009/1509	(07-59S, 080-29E)	TurboMAP (#139-1; 300m)
	2030/1530	(07-59S, 080-29E)	TurboMAP (#139-2; 300m)
	2055/1555		Flux (#135)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#167)
	2237/1737	(08-00S, 080-29E)	CTD (#143; 500m),With sampling seawater
	2323/1823	(07-59S, 080-29E)	TurboMAP (#140-1; 300m)
	2339/1839	(07-59S, 080-29E)	TurboMAP (#140-2; 300m)
18	0000/1900		Flux (#136)
	0130/2030	(07-59S, 080-30E)	Radiosonde (#168)
	0135/2035	(07-59S, 080-29E)	CTD (#144; 500m)
	0207/2107	(07-59S, 080-29E)	TurboMAP (#141-1; 300m)
	0225/2125	(07-59S, 080-29E)	TurboMAP (#141-2; 300m)
	0245/2145		Flux (#137)
	0430/2330	(07-59S, 080-30E)	Radiosonde (#169)
	0436/2336	(08-00S, 080-29E)	CTD (#145; 500m),With sampling seawater
	0524/0024	(07-59S, 080-29E)	TurboMAP (#142-1; 300m)
	0541/0041	(07-59S, 080-29E)	TurboMAP (#142-2; 300m)
	0602/0102		Flux (#138)
	0730/0230	(08-00S, 080-29E)	Radiosonde (#170)
	0737/0237	(08-00S, 080-29E)	CTD (#146; 500m)
	0810/0310	(07-59S, 080-29E)	TurboMAP (#143-1; 300m)
	0828/0328	(07-59S, 080-29E)	TurboMAP (#143-2; 300m)
	0853/0353		Flux (#139)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#171)
	1035/0535	(08-00S, 080-30E)	CTD (#147; 1000m),With sampling seawater
	1136/0636	(08-00S, 080-30E)	TurboMAP (#144-1; 300m)
	1155/0655	(08-00S, 080-29E)	TurboMAP (#144-2; 300m)
	1215/0715		Flux (#140)
	1330/0830	(07-59S, 080-30E)	Radiosonde (#172)
	1336/0836	(08-00S, 080-29E)	CTD (#148; 500m)
	1407/0907	(07-59S, 080-29E)	TurboMAP (#145-1; 300m)
	1425/0925	(07-59S, 080-29E)	TurboMAP (#145-2; 300m)
	1447/0947		Flux (#141)
	1630/1130	(07-59S, 080-29E)	Radiosonde (#173)
	1634/1134	(08-00S, 080-30E)	CTD (#149; 500m),With sampling seawater
	1721/1221	(07-59S, 080-29E)	TurboMAP (#146-1; 300m)
	1740/1240	(07-59S, 080-29E)	TurboMAP (#146-2; 300m)
	1802/1302		Flux (#142)
	1930/1430	(07-58S, 080-29E)	Radiosonde (#174)
	1936/1436	(07-58S, 080-29E)	CTD (#150; 500m)
	2007/1507	(07-58S, 080-29E)	TurboMAP (#147-1; 300m)
	2026/1526	(07-58S, 080-28E)	TurboMAP (#147-2; 300m)
	2052/1552	(07-59S, 080-29E)	Sea skater collection (#14-1)
	2112/1612	(07-59S, 080-29E)	Sea skater collection (#14-2)
	2132/1632	(08-00S, 080-29E)	Sea skater collection (#14-3)
	2152/1652		Flux (#143)
	2230/1730	(07-59S, 080-30E)	Radiosonde (#175)
	2235/1735	(07-59S, 080-29E)	CTD (#151; 500m),With sampling seawater
	2320/1820	(07-59S, 080-29E)	TurboMAP (#148-1; 300m)
	2336/1836	(07-59S, 080-29E)	TurboMAP (#148-2; 300m)
19	2356/1856		Flux (#144)

	0130/2030	(08-00S, 080-30E)	Radiosonde (#176)
	0135/2035	(08-00S, 080-30E)	CTD (#152; 500m)
	0207/2107	(08-00S, 080-29E)	TurboMAP (#149-1; 300m)
	0225/2125	(07-59S, 080-29E)	TurboMAP (#149-2; 300m)
	0245/2145		Flux (#145)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#177)
	0436/2336	(08-00S, 080-30E)	CTD (#153; 500m),With sampling seawater
	0524/0024	(08-00S, 080-29E)	TurboMAP (#150-1; 300m)
	0541/0041	(08-00S, 080-29E)	TurboMAP (#150-2; 300m)
	0600/0100		Flux (#146)
	0730/0230	(07-59S, 080-30E)	Radiosonde (#178)
	0736/0236	(08-00S, 080-30E)	CTD (#154; 500m)
	0808/0308	(07-59S, 080-29E)	TurboMAP (#151-1; 300m)
	0828/0328	(07-59S, 080-29E)	TurboMAP (#151-2; 300m)
	0848/0348		Flux (#147)
	1030/0530	(08-00S, 080-29E)	Radiosonde (#179)
	1035/0535	(08-00S, 080-29E)	CTD (#155; 1000m),With sampling seawater
	1135/0635	(08-00S, 080-29E)	TurboMAP (#152-1; 300m)
	1153/0653	(07-59S, 080-29E)	TurboMAP (#152-2; 300m)
	1212/0712		Flux (#148)
	1330/0830	(07-59S, 080-30E)	Radiosonde (#180)
	1335/0835	(08-10S, 080-29E)	CTD (#156; 500m)
	1406/0906	(07-59S, 080-30E)	TurboMAP (#153-1; 300m)
	1424/0924	(07-59S, 080-29E)	TurboMAP (#153-2; 300m)
	1521/1021	(08-00S, 080-30E)	CFH Radiosonde (#02)
	1522/1022		Flux (#149)
	1630/1130	(07-59S, 080-30E)	Radiosonde (#181)
	1635/1135	(07-59S, 080-30E)	CTD (#157; 500m),With sampling seawater
	1721/1221	(07-59S, 080-30E)	TurboMAP (#154-1; 300m)
	1740/1240	(07-59S, 080-29E)	TurboMAP (#154-2; 300m)
	1803/1303		Flux (#150)
	1930/1430	(07-58S, 080-29E)	Radiosonde (#182)
	1935/1435	(07-58S, 080-29E)	CTD (#158; 500m)
	2008/1508	(07-58S, 080-29E)	TurboMAP (#155-1; 300m)
	2027/1527	(07-58S, 080-29E)	TurboMAP (#155-2; 300m)
	2054/1554	(07-58S, 080-29E)	Sea skater collection (#15-1)
	2114/1614	(08-00S, 080-29E)	Sea skater collection (#15-2)
	2134/1634	(08-00S, 080-30E)	Sea skater collection (#15-3)
	2155/1655		Flux (#151)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#183)
	2235/1735	(07-59S, 080-30E)	CTD (#159; 500m),With sampling seawater
	2318/1818	(07-59S, 080-30E)	TurboMAP (#156-1; 300m)
	2335/1835	(07-59S, 080-29E)	TurboMAP (#156-2; 300m)
20	2355/1855		Flux (#152)
	0130/2030	(07-59S, 080-30E)	Radiosonde (#184)
	0135/2035	(07-59S, 080-30E)	CTD (#160; 500m)
	0208/2108	(07-59S, 080-30E)	TurboMAP (#157-1; 300m)
	0227/2127	(07-59S, 080-29E)	TurboMAP (#157-2; 300m)
	0247/2147		Flux (#153)
	0430/2330	(07-59S, 080-30E)	Radiosonde (#185)
	0435/2335	(07-59S, 080-30E)	CTD (#161; 500m),With sampling seawater
	0524/0024	(07-59S, 080-30E)	TurboMAP (#158-1; 300m)
	0540/0040	(07-59S, 080-29E)	TurboMAP (#158-2; 300m)
	0600/0100		Flux (#154)
	0731/0231	(08-00S, 080-30E)	Radiosonde (#186)
	0735/0235	(07-59S, 080-30E)	CTD (#162; 500m)
	0810/0310	(07-59S, 080-30E)	TurboMAP (#159-1; 300m)
	0828/0328	(07-59S, 080-30E)	TurboMAP (#159-2; 300m)
	0856/0356		Flux (#154)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#187)
	1034/0534	(07-59S, 080-30E)	CTD (#163; 500m),With sampling seawater

	1118/0618	(07-59S, 080-31E)	TurboMAP (#160-1; 300m)
	1135/0635	(07-59S, 080-31E)	TurboMAP (#160-2; 300m)
	1151/0651	(07-59S, 080-31E)	TurboMAP (#160-3; 300m)
	1207/0707	(07-59S, 080-31E)	TurboMAP (#160-4; 300m)
	1224/0724	(07-59S, 080-31E)	TurboMAP (#160-5; 300m)
	1239/0739	(07-59S, 080-31E)	TurboMAP (#160-6; 300m)
	1330/0830	(08-00S, 080-31E)	Radiosonde (#188)
	1336/0836	(07-59S, 080-31E)	CTD (#164; 500m)
	1417/0917	(07-59S, 080-31E)	TurboMAP (#161-1; 300m)
	1435/0935	(07-59S, 080-31E)	TurboMAP (#161-2; 300m)
	1450/0950	(07-59S, 080-31E)	TurboMAP (#161-3; 300m)
	1506/1006	(07-59S, 080-31E)	TurboMAP (#161-4; 300m)
	1523/1023	(07-59S, 080-31E)	TurboMAP (#161-5; 300m)
	1540/1040	(07-59S, 080-31E)	TurboMAP (#161-6; 300m)
	1605/1105	(07-59S, 080-31E)	TurboMAP (#161-7; 300m)
	1630/1130	(08-00S, 080-31E)	Radiosonde (#189)
	1634/1134	(07-59S, 080-31E)	CTD (#165; 500m),With sampling seawater
	1721/1221	(07-59S, 080-31E)	TurboMAP (#162-1; 300m)
	1740/1240	(07-59S, 080-31E)	TurboMAP (#162-2; 300m)
	1755/1255	(07-59S, 080-31E)	TurboMAP (#162-3; 300m)
	1812/1312	(07-59S, 080-31E)	TurboMAP (#162-4; 300m)
	1829/1329	(07-59S, 080-31E)	TurboMAP (#162-5; 300m)
	1847/1347	(07-59S, 080-31E)	TurboMAP (#162-6; 300m)
	1930/1430	(07-59S, 080-31E)	Radiosonde (#190)
	1936/1436	(07-59S, 080-31E)	CTD (#166; 500m)
	2010/1510	(07-59S, 080-31E)	TurboMAP (#163-1; 300m)
	2027/1527	(07-59S, 080-31E)	TurboMAP (#163-2; 300m)
	2042/1542	(07-59S, 080-31E)	TurboMAP (#163-3; 300m)
	2057/1557	(07-59S, 080-31E)	TurboMAP (#163-4; 300m)
	2114/1614	(07-59S, 080-31E)	TurboMAP (#163-5; 300m)
	2129/1629	(07-59S, 080-31E)	TurboMAP (#163-6; 300m)
	2144/1644	(07-59S, 080-31E)	TurboMAP (#163-7; 300m)
	2230/1730	(08-00S, 080-31E)	Radiosonde (#191)
	2235/1735	(08-00S, 080-31E)	CTD (#167; 500m),With sampling seawater
	2321/1821	(07-59S, 080-31E)	TurboMAP (#164-1; 300m)
	2339/1839	(07-59S, 080-31E)	TurboMAP (#164-2; 300m)
	2355/1855	(07-59S, 080-31E)	TurboMAP (#164-3; 300m)
	0011/1911	(07-59S, 080-31E)	TurboMAP (#164-4; 300m)
	0028/1928	(07-59S, 080-31E)	TurboMAP (#164-5; 300m)
	0045/1945	(07-59S, 080-31E)	TurboMAP (#164-6; 300m)
21	0130/2030	(08-00S, 080-31E)	Radiosonde (#192)
	0134/2034	(07-59S, 080-31E)	CTD (#168; 500m)
	0211/2111	(07-59S, 080-31E)	TurboMAP (#165-1; 300m)
	0230/2130	(07-59S, 080-31E)	TurboMAP (#165-2; 300m)
	0249/2149	(07-59S, 080-31E)	TurboMAP (#165-3; 300m)
	0306/2206	(07-59S, 080-31E)	TurboMAP (#165-4; 300m)
	0324/2224	(07-59S, 080-31E)	TurboMAP (#165-5; 300m)
	0340/2240	(07-59S, 080-31E)	TurboMAP (#165-6; 300m)
	0430/2330	(08-00S, 080-31E)	Radiosonde (#193)
	0435/2335	(07-59S, 080-31E)	CTD (#169; 500m),With sampling seawater
	0524/0024	(07-59S, 080-31E)	TurboMAP (#166-1; 300m)
	0544/0044	(07-59S, 080-31E)	TurboMAP (#166-2; 300m)
	0601/0101	(07-59S, 080-31E)	TurboMAP (#166-3; 300m)
	0619/0119	(07-59S, 080-31E)	TurboMAP (#166-4; 300m)
	0637/0137	(07-59S, 080-31E)	TurboMAP (#166-5; 300m)
	0655/0155	(07-59S, 080-31E)	TurboMAP (#166-6; 300m)
	0731/0231	(07-59S, 080-31E)	Radiosonde (#194)
	0735/0235	(07-59S, 080-31E)	CTD (#170; 500m)
	0812/0312	(07-59S, 080-31E)	TurboMAP (#167-1; 300m)
	0829/0329	(07-59S, 080-31E)	TurboMAP (#167-2; 300m)
	0849/0349	(07-59S, 080-31E)	TurboMAP (#167-3; 300m)

	0907/0407	(07-59S, 080-31E)	TurboMAP (#167-4; 300m)
	0925/0425	(07-59S, 080-31E)	TurboMAP (#167-5; 300m)
	0942/0442	(07-59S, 080-31E)	TurboMAP (#167-6; 300m)
	1030/0530	(07-59S, 080-31E)	Radiosonde (#195)
	1034/0534	(07-59S, 080-31E)	CTD (#171; 1000m),With sampling seawater
	1137/0637	(07-59S, 080-30E)	TurboMAP (#168-1; 300m)
	1159/0659	(07-59S, 080-30E)	TurboMAP (#168-2; 300m)
	1218/0718		Flux (#156)
	1330/0830	(07-59S, 080-31E)	Radiosonde (#196)
	1335/0835	(07-59S, 080-31E)	CTD (#172; 500m)
	1415/0915	(07-59S, 080-29E)	TurboMAP (#169-1; 300m)
	1434/0934	(07-59S, 080-29E)	TurboMAP (#169-2; 300m)
	1530/1030	(07-59S, 080-31E)	CFH Radiosonde (#03)
	1617/1117		Flux (#157)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#197)
	1625/1125	(08-00S, 080-30E)	TurboMAP (#170-1; 300m)
	1654/1154	(08-00S, 080-30E)	TurboMAP (#170-2; 300m)
	1726/1226	(07-59S, 080-29E)	CTD (#173; 600m),With sampling seawater
	1813/1313		Flux (#158)
	1930/1430	(07-58S, 080-30E)	Radiosonde (#198)
	1935/1435	(07-58S, 080-29E)	CTD (#174; 500m)
	2013/1513	(07-58S, 080-29E)	TurboMAP (#171-1; 300m)
	2033/1533	(07-58S, 080-29E)	TurboMAP (#171-2; 300m)
	2059/1559	(07-58S, 080-29E)	Sea skater collection (#16-1)
	2118/1618	(07-58S, 080-29E)	Sea skater collection (#16-2)
	2138/1638	(08-00S, 080-30E)	Sea skater collection (#16-3)
	2200/1700		Flux (#159)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#199)
	2235/1735	(07-59S, 080-29E)	CTD (#175; 500m),With sampling seawater
	2324/1824	(07-59S, 080-29E)	TurboMAP (#172-1; 300m)
	2341/1841	(07-59S, 080-29E)	TurboMAP (#172-2; 300m)
22	0002/1902		Flux (#160)
	0130/2030	(07-59S, 080-30E)	Radiosonde (#200)
	0134/2034	(07-59S, 080-30E)	CTD (#176; 500m)
	0207/2107	(07-59S, 080-29E)	TurboMAP (#173-1; 300m)
	0224/2124	(07-59S, 080-29E)	TurboMAP (#173-2; 300m)
	0245/2145		Flux (#161)
	0448/2348	(08-00S, 080-29E)	Radiosonde (#201)
	0452/2352	(08-00S, 080-29E)	CTD (#177; 500m),With sampling seawater
	0539/0039	(07-59S, 080-29E)	TurboMAP (#174-1; 300m)
	0557/0057	(07-59S, 080-29E)	TurboMAP (#174-2; 300m)
	0617/0117		Flux (#162)
	0731/0231	(08-00S, 080-29E)	Radiosonde (#202)
	0735/0235	(08-00S, 080-29E)	CTD (#178; 500m)
	0809/0309	(08-00S, 080-29E)	TurboMAP (#175-1; 300m)
	0828/0328	(08-00S, 080-29E)	TurboMAP (#175-2; 300m)
	0850/0350		Flux (#163)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#203)
	1034/0534	(08-00S, 080-29E)	CTD (#179; 1000m),With sampling seawater
	1137/0637	(07-59S, 080-29E)	TurboMAP (#176-1; 300m)
	1155/0655	(07-59S, 080-29E)	TurboMAP (#176-2; 300m)
	1218/0718		Flux (#164)
	1330/0830	(08-00S, 080-29E)	Radiosonde (#204)
	1335/0835	(08-00S, 080-29E)	CTD (#180; 500m)
	1406/0906	(08-00S, 080-29E)	TurboMAP (#177-1; 300m)
	1425/0925	(08-00S, 080-29E)	TurboMAP (#177-2; 300m)
	1446/0946		Flux (#165)
	1631/1131	(08-00S, 080-29E)	Radiosonde (#205)
	1635/1135	(08-00S, 080-29E)	CTD (#181; 500m),With sampling seawater
	1719/1219	(07-59S, 080-29E)	TurboMAP (#178-1; 300m)
	1740/1240	(07-59S, 080-29E)	TurboMAP (#178-2; 300m)

	1801/1301		Flux (#166)
	1930/1430	(07-58S, 080-29E)	Radiosonde (#206)
	1935/1435	(07-58S, 080-29E)	CTD (#182; 500m)
	2009/1509	(07-58S, 080-29E)	TurboMAP (#179-1; 300m)
	2027/1527	(07-58S, 080-29E)	TurboMAP (#179-2; 300m)
	2051/1551	(07-59S, 080-29E)	Sea skater collection (#17-1)
	2111/1611	(07-59S, 080-29E)	Sea skater collection (#17-2)
	2131/1631	(08-00S, 080-29E)	Sea skater collection (#17-3)
	2153/1653		Flux (#167)
	2241/1741	(08-00S, 080-30E)	Radiosonde (#207)
	2246/1746	(08-00S, 080-30E)	CTD (#183; 500m),With sampling seawater
	2332/1732	(07-59S, 080-29E)	TurboMAP (#180-1; 300m)
	2351/1851	(07-59S, 080-29E)	TurboMAP (#180-2; 300m)
23	0010/1910		Flux (#168)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#208)
	0134/2034	(08-00S, 080-30E)	CTD (#184; 500m)
	0208/2108	(07-59S, 080-29E)	TurboMAP (#181-1; 300m)
	0225/2125	(08-00S, 080-29E)	TurboMAP (#181-2; 300m)
	0245/2145		Flux (#169)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#209)
	0435/2335	(08-00S, 080-30E)	CTD (#185; 500m),With sampling seawater
	0523/0023	(07-59S, 080-29E)	TurboMAP (#182-1; 300m)
	0541/0041	(07-59S, 080-29E)	TurboMAP (#182-2; 300m)
	0602/0102		Flux (#170)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#210)
	0734/0234	(08-00S, 080-29E)	CTD (#186; 500m)
	0809/0309	(08-00S, 080-29E)	TurboMAP (#183-1; 300m)
	0826/0326	(08-00S, 080-29E)	TurboMAP (#183-2; 300m)
	0847/0347		Flux (#171)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#211)
	1034/0534	(08-00S, 080-29E)	CTD (#187; 1000m),With sampling seawater
	1136/0636	(07-59S, 080-29E)	TurboMAP (#184-1; 300m)
	1155/0655	(07-59S, 080-29E)	TurboMAP (#184-2; 300m)
	1216/0716		Flux (#172)
	1330/0830	(08-00S, 080-29E)	Radiosonde (#212)
	1334/0834	(08-00S, 080-29E)	CTD (#188; 500m)
	1407/0907	(08-00S, 080-29E)	TurboMAP (#185-1; 300m)
	1426/0926	(08-00S, 080-29E)	TurboMAP (#185-2; 300m)
	1447/0947		Flux (#173)
	1631/1131	(07-59S, 080-30E)	Radiosonde (#213)
	1635/1135	(07-59S, 080-30E)	CTD (#189; 500m),With sampling seawater
	1718/1218	(07-59S, 080-29E)	TurboMAP (#186-1; 300m)
	1720/1220	(07-59S, 080-29E)	TurboMAP (#186-2; 300m)
	1756/1256		Flux (#174)
	1930/1430	(07-59S, 080-30E)	Radiosonde (#214)
	1934/1434	(07-59S, 080-30E)	CTD (#190; 500m)
	2008/1508	(07-59S, 080-29E)	TurboMAP (#187-1; 300m)
	2027/1527	(07-59S, 080-29E)	TurboMAP (#187-2; 300m)
	2047/1547		Flux (#175)
	2230/1730	(08-00S, 080-29E)	Radiosonde (#215)
	2235/1735	(08-00S, 080-29E)	CTD (#191; 500m),With sampling seawater
	2320/1820	(07-59S, 080-29E)	TurboMAP (#188-1; 300m)
	2340/1840	(07-59S, 080-29E)	TurboMAP (#188-2; 300m)
24	0000/1900		Flux (#176)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#216)
	0134/2034	(08-00S, 080-30E)	CTD (#192; 500m)
	0206/2106	(08-00S, 080-29E)	TurboMAP (#189-1; 300m)
	0224/2124	(08-00S, 080-29E)	TurboMAP (#189-2; 300m)
	0244/2144		Flux (#177)
	0431/2331	(08-00S, 080-30E)	Radiosonde (#217)
	0435/2335	(08-00S, 080-30E)	CTD (#193; 500m),With sampling seawater

	0521/0021	(07-59S, 080-29E)	TurboMAP (#190-1; 300m)
	0540/0040	(07-59S, 080-29E)	TurboMAP (#190-2; 300m)
	0600/0100		Flux (#178)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#218)
	0735/0235	(08-00S, 080-29E)	CTD (#194; 500m)
	0808/0308	(08-00S, 080-29E)	TurboMAP (#191-1; 300m)
	0827/0327	(08-00S, 080-29E)	TurboMAP (#191-2; 300m)
	0913/0413		Flux (#179)
	1033/0533	(08-00S, 080-29E)	Radiosonde (#219)
	1037/0537	(08-00S, 080-29E)	CTD (#195; 1000m),With sampling seawater
	1144/0644		Recover "Sea-Snake" SSST sensor
	1330/0830	(07-36S, 080-29E)	Radiosonde (#220)
	1631/1130	(06-52S, 080-29E)	Radiosonde (#221)
	1931/1430	(06-08S, 080-29E)	Radiosonde (#222)
	2230/1730	(05-24S, 080-29E)	Radiosonde (#223)
25	0130/2030	(04-40S, 080-29E)	Radiosonde (#224)
	0431/2331	(03-55S, 080-31E)	Radiosonde (#225)
	0733/0233	(03-11S, 080-30E)	Radiosonde (#226)
	1031/0531	(02-28S, 080-30E)	Radiosonde (#227)
	1331/0831	(01-45S, 080-30E)	Radiosonde (#228)
	1430/0930	(01-30S, 080-30E)	RAMA buoy inspection
	1631/1131	(01-03S, 080-21E)	Radiosonde (#229)
	1930/1430	(00-23S, 080-06E)	Radiosonde (#230)
	2230/1730	(00-00S, 080-00E)	Radiosonde (#231)
26	0130/2030	(00-33N, 080-57E)	Radiosonde (#232)
	0431/2331	(01-17N, 079-56E)	Radiosonde (#233)
	0610/0110	Stop of Doppler radar observation	
	----/1700	Revision of Ship Mean Time (to UTC+5.5h)	
27	1000/0430	Arrival at Colombo, Sri Lanka	
28	0900/0330	Departure from Colombo, Sri Lanka	
	----/1630	Revision of Ship Mean Time (to UTC+5h)	
29	0520/0020	Starting Doppler radar observation	
	0730/0230	(01-38N, 079-55E)	Radiosonde (#234)
	1049/0549	(00-57N, 080-02E)	Radiosonde (#235)
	1330/0830	(00-19N, 080-04E)	Radiosonde (#236)
	1631/1131	(00-22S, 080-09E)	Radiosonde (#237)
	1930/1430	(01-06S, 080-13E)	Radiosonde (#238)
	2229/1729	(01-49S, 080-16E)	Radiosonde (#239)
30	0130/2030	(02-32S, 080-21E)	Radiosonde (#240)
	0430/2330	(03-13S, 080-27E)	Radiosonde (#241)
	0730/0230	(03-54S, 080-30E)	Radiosonde (#242)
	0750/0250	(03-59S, 080-30E)	RAMA buoy inspection
	1030/0530	(04-29S, 080-31E)	Radiosonde (#243)
	1330/0830	(05-10S, 080-30E)	Radiosonde (#244)
	1631/1131	(05-50S, 080-31E)	Radiosonde (#245)
	1931/1431	(06-28S, 080-29E)	Radiosonde (#246)
	2230/1730	(07-08S, 080-30E)	Radiosonde (#247)
31	0130/2030	(07-47S, 080-30E)	Radiosonde (#248)
	0300/2200	(08-01S, 080-30E)	Testing 3-dimensional magnetometer
	0430/2330	(08-00S, 080-30E)	Radiosonde (#249)
	0434/2334	(08-00S, 080-30E)	CTD (#196; 500m),With sampling seawater
	0522/0022	(08-00S, 080-30E)	TurboMAP (#192-1; 300m)
	0538/0038	(08-00S, 080-30E)	TurboMAP (#192-2; 300m)
	0600/0100		Flux (#180)
	0731/0231	(08-00S, 080-30E)	Radiosonde (#250)
	0736/0236	(08-00S, 080-30E)	CTD (#197; 500m)
	0810/0310	(08-00S, 080-30E)	TurboMAP (#193-1; 300m)
	0828/0328	(08-00S, 080-30E)	TurboMAP (#193-2; 300m)
	0920/0420		Flux (#181)
	0928/0428		Deploy "Sea-Snake" SSST sensor
	1030/0530	(08-01S, 080-30E)	Radiosonde (#251)

	1034/0534	(08-00S, 080-30E)	CTD (#198; 1000m),With sampling seawater
	1135/0635	(08-00S, 080-30E)	TurboMAP (#194-1; 300m)
	1155/0655	(08-00S, 080-30E)	TurboMAP (#194-2; 300m)
	1215/0715		Flux (#182)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#252)
	1334/0834	(08-00S, 080-30E)	CTD (#199; 500m)
	1406/0906	(08-00S, 080-30E)	TurboMAP (#195-1; 300m)
	1424/0924	(08-00S, 080-30E)	TurboMAP (#195-2; 300m)
	1445/0945		Flux (#183)
	1448/0948	(08-00S, 080-30E)	Radiosonde (#M004)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#253)
	1634/1134	(08-00S, 080-30E)	CTD (#200; 500m),With sampling seawater
	1722/1222	(08-00S, 080-30E)	TurboMAP (#196-1; 300m)
	1740/1240	(08-00S, 080-30E)	TurboMAP (#196-2; 300m)
	1800/1300		Flux (#184)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#254)
	1933/1433	(08-00S, 080-30E)	CTD (#201; 500m)
	2008/1508	(08-00S, 080-30E)	TurboMAP (#197-1; 300m)
	2030/1530	(08-00S, 080-29E)	TurboMAP (#197-2; 300m)
	2053/1553	(08-00S, 080-29E)	Sea skater collection (#018-1)
	2113/1613	(08-00S, 080-30E)	Sea skater collection (#018-2)
	2134/1634	(08-00S, 080-31E)	Sea skater collection (#018-3)
	2152/1652		Flux (#185)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#255)
	2233/1733	(08-00S, 080-30E)	CTD (#202; 500m),With sampling seawater
	2320/1820	(08-00S, 080-30E)	TurboMAP (#198-1; 300m)
	2341/1841	(08-00S, 080-30E)	TurboMAP (#198-2; 300m)
Nov.1	0001/1901		Flux (#186)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#256)
	0134/2034	(08-00S, 080-30E)	CTD (#203; 500m)
	0206/2106	(08-00S, 080-30E)	TurboMAP (#199-1; 300m)
	0225/2125	(08-00S, 080-30E)	TurboMAP (#199-2; 300m)
	0245/2145		Flux (#187)
	0431/2331	(08-00S, 080-30E)	Radiosonde (#257)
	0434/2334	(08-00S, 080-30E)	CTD (#204; 500m),With sampling seawater
	0522/0022	(08-00S, 080-30E)	TurboMAP (#200-1; 300m)
	0539/0039	(08-00S, 080-30E)	TurboMAP (#200-2; 300m)
	0558/0058		Flux (#188)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#258)
	0733/0233	(08-00S, 080-30E)	CTD (#205; 500m)
	0808/0308	(08-00S, 080-30E)	TurboMAP (#201-1; 300m)
	0823/0323	(08-00S, 080-30E)	TurboMAP (#201-2; 300m)
	0843/0343		Flux (#189)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#259)
	1033/0533	(08-00S, 080-30E)	CTD (#206; 1000m),With sampling seawater
	1136/0636	(08-00S, 080-30E)	TurboMAP (#202-1; 300m)
	1153/0653	(07-59S, 080-30E)	TurboMAP (#202-2; 300m)
	1215/0715		Flux (#190)
	1331/0831	(08-00S, 080-30E)	Radiosonde (#260)
	1334/0834	(08-00S, 080-30E)	CTD (#207; 500m)
	1405/0905	(08-00S, 080-30E)	TurboMAP (#203-1; 300m)
	1422/0922	(08-00S, 080-30E)	TurboMAP (#203-2; 300m)
	1445/0945		Flux (#191)
	1502/1002	(08-00S, 080-30E)	CFH Radiosonde (#004)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#261)
	1636/1136	(08-00S, 080-30E)	CTD (#208; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#204-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#204-2; 300m)
	1800/1300		Flux (#192)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#262)
	1934/1434	(08-00S, 080-30E)	CTD (#209; 500m)

	2007/1507	(08-00S, 080-30E)	TurboMAP (#205-1; 300m)
	2026/1526	(08-00S, 080-30E)	TurboMAP (#205-2; 300m)
	2050/1550	(08-00S, 080-30E)	Sea skater collection (#019-1)
	2113/1613	(08-01S, 080-30E)	Sea skater collection (#019-2)
	2133/1633	(08-01S, 080-30E)	Sea skater collection (#019-3)
	2152/1652		Flux (#193)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#263)
	2233/1733	(08-00S, 080-30E)	CTD (#210; 500m),With sampling seawater
	2321/1821	(08-00S, 080-30E)	TurboMAP (#206-1; 300m)
	2340/1840	(08-00S, 080-30E)	TurboMAP (#206-2; 300m)
2	0000/1900		Flux (#194)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#264)
	0133/2033	(08-00S, 080-30E)	CTD (#211; 500m)
	0208/2108	(08-00S, 080-30E)	TurboMAP (#207-1; 300m)
	0226/2126	(08-00S, 080-30E)	TurboMAP (#207-2; 300m)
	0248/2148		Flux (#195)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#265)
	0433/2333	(08-00S, 080-30E)	CTD (#212; 500m),With sampling seawater
	0519/0019	(08-00S, 080-30E)	TurboMAP (#208-1; 300m)
	0535/0035	(08-00S, 080-30E)	TurboMAP (#208-2; 300m)
	0554/0054		Flux (#196)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#266)
	0734/0234	(08-00S, 080-30E)	CTD (#213; 500m)
	0808/0308	(08-00S, 080-30E)	TurboMAP (#209-1; 300m)
	0829/0329	(08-00S, 080-30E)	TurboMAP (#209-2; 300m)
	0850/0350		Flux (#197)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#267)
	1034/0534	(08-00S, 080-30E)	CTD (#214; 1000m),With sampling seawater
	1135/0635	(08-00S, 080-30E)	TurboMAP (#210-1; 300m)
	1155/0655	(07-59S, 080-30E)	TurboMAP (#210-2; 300m)
	1217/0717		Flux (#198)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#268)
	1334/0834	(08-00S, 080-30E)	CTD (#215; 500m)
	1406/0906	(08-01S, 080-30E)	TurboMAP (#211-1; 300m)
	1424/0924	(08-00S, 080-30E)	TurboMAP (#211-2; 300m)
	1445/0945		Flux (#199)
	1545/1045	(08-01S, 080-30E)	CFH Radiosonde (#005)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#269)
	1633/1133	(08-00S, 080-30E)	CTD (#216; 500m),With sampling seawater
	1719/1219	(08-00S, 080-29E)	TurboMAP (#212-1; 300m)
	1736/1236	(08-00S, 080-29E)	TurboMAP (#212-2; 300m)
	1757/1257		Flux (#200)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#270)
	1940/1440	(08-00S, 080-30E)	CTD (#217; 500m)
	2015/1515	(08-00S, 080-30E)	TurboMAP (#213-1; 300m)
	2032/1532	(08-00S, 080-30E)	TurboMAP (#213-2; 300m)
	2056/1556	(08-00S, 080-30E)	Sea skater collection (#020-1)
	2116/1616	(08-00S, 080-30E)	Sea skater collection (#020-2)
	2136/1636	(08-00S, 080-31E)	Sea skater collection (#020-3)
	2155/1655		Flux (#201)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#271)
	2239/1739	(08-00S, 080-30E)	CTD (#218; 500m),With sampling seawater
	2327/1827	(08-00S, 080-30E)	TurboMAP (#214-1; 300m)
	2345/1845	(08-00S, 080-30E)	TurboMAP (#214-2; 300m)
3	0006/1906		Flux (#202)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#272)
	0138/2038	(08-00S, 080-30E)	CTD (#219; 500m)
	0212/2112	(08-00S, 080-30E)	TurboMAP (#215-1; 300m)
	0230/2130	(08-00S, 080-30E)	TurboMAP (#215-2; 300m)
	0250/2150		Flux (#203)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#273)

	0435/2335	(08-00S, 080-30E)	CTD (#220; 500m),With sampling seawater
	0522/0022	(08-00S, 080-30E)	TurboMAP (#216-1; 300m)
	0537/0037	(08-00S, 080-30E)	TurboMAP (#216-2; 300m)
	0600/0100		Flux (#204)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#274)
	0740/0240	(08-00S, 080-30E)	CTD (#221; 500m)
	0815/0315	(08-00S, 080-30E)	TurboMAP (#217-1; 300m)
	0836/0336	(08-00S, 080-30E)	TurboMAP (#217-2; 300m)
	0858/0358		Flux (#205)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#275)
	1040/0540	(08-00S, 080-30E)	CTD (#222; 1000m),With sampling seawater
	1141/0641	(08-00S, 080-30E)	TurboMAP (#218-1; 300m)
	1159/0659	(08-00S, 080-29E)	TurboMAP (#218-2; 300m)
	1216/0716		Flux (#206)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#276)
	1339/0839	(08-00S, 080-29E)	CTD (#223; 500m)
	1411/0911	(07-59S, 080-30E)	TurboMAP (#219-1; 300m)
	1429/0929	(08-00S, 080-30E)	TurboMAP (#219-2; 300m)
	1447/0947		Flux (#207)
	1506/1006	(08-00S, 080-30E)	CFH Radiosonde (#006)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#277)
	1639/1139	(08-00S, 080-30E)	CTD (#224; 500m),With sampling seawater
	1725/1225	(08-00S, 080-30E)	TurboMAP (#220-1; 300m)
	1742/1242	(08-00S, 080-30E)	TurboMAP (#220-2; 300m)
	1801/1301		Flux (#208)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#278)
	1939/1439	(08-00S, 080-30E)	CTD (#225; 500m)
	2014/1514	(08-00S, 080-30E)	TurboMAP (#221-1; 300m)
	2032/1532	(08-00S, 080-30E)	TurboMAP (#221-2; 300m)
	2055/1555	(08-00S, 080-30E)	Sea skater collection (#021-1)
	2115/1615	(08-00S, 080-30E)	Sea skater collection (#021-2)
	2134/1634	(08-00S, 080-31E)	Sea skater collection (#021-3)
	2153/1653		Flux (#209)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#279)
	2237/1737	(08-00S, 080-30E)	CTD (#226; 500m),With sampling seawater
	2324/1824	(08-00S, 080-30E)	TurboMAP (#222-1; 300m)
	2341/1841	(08-00S, 080-30E)	TurboMAP (#222-2; 300m)
4	0003/1903		Flux (#210)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#280)
	0138/2038	(08-00S, 080-30E)	CTD (#227; 500m)
	0210/2110	(08-00S, 080-30E)	TurboMAP (#223-1; 300m)
	0228/2128	(08-00S, 080-30E)	TurboMAP (#223-2; 300m)
	0247/2147		Flux (#211)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#281)
	0439/2339	(08-00S, 080-30E)	CTD (#228; 500m),With sampling seawater
	0526/0026	(08-00S, 080-30E)	TurboMAP (#224-1; 300m)
	0542/0042	(08-00S, 080-30E)	TurboMAP (#224-2; 300m)
	0600/0100		Flux (#212)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#282)
	0740/0240	(08-00S, 080-30E)	CTD (#229; 500m)
	0814/0314	(08-00S, 080-30E)	TurboMAP (#225-1; 300m)
	0831/0331	(08-00S, 080-30E)	TurboMAP (#225-2; 300m)
	0850/0350		Flux (#213)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#283)
	1039/0539	(08-00S, 080-30E)	CTD (#230; 1000m),With sampling seawater
	1141/0641	(08-00S, 080-30E)	TurboMAP (#226-1; 300m)
	1159/0659	(07-59S, 080-30E)	TurboMAP (#226-2; 300m)
	1220/0720		Flux (#214)
	1241/0741	(08-00S, 080-31E)	CFH Radiosonde (#007)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#284)
	1338/0838	(08-00S, 080-30E)	CTD (#231; 500m)

	1410/0910	(07-59S, 080-30E)	TurboMAP (#227-1; 300m)
	1427/0927	(08-00S, 080-30E)	TurboMAP (#227-2; 300m)
	1445/0945		Flux (#215)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#285)
	1638/1138	(08-00S, 080-30E)	CTD (#232; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#228-1; 300m)
	1742/1242	(08-00S, 080-30E)	TurboMAP (#228-2; 300m)
	1802/1302		Flux (#216)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#286)
	1939/1439	(08-00S, 080-30E)	CTD (#233; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#229-1; 300m)
	2029/1529	(08-00S, 080-30E)	TurboMAP (#229-2; 300m)
	2054/1554	(08-00S, 080-30E)	Sea skater collection (#022-1)
	2114/1614	(08-00S, 080-31E)	Sea skater collection (#022-2)
	2134/1634	(08-00S, 080-31E)	Sea skater collection (#022-3)
	2151/1651		Flux (#217)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#287)
	2237/1737	(08-00S, 080-30E)	CTD (#234; 500m),With sampling seawater
	2324/1824	(08-00S, 080-30E)	TurboMAP (#230-1; 300m)
	2341/1841	(08-00S, 080-30E)	TurboMAP (#230-2; 300m)
5	0002/1902		Flux (#218)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#288)
	0136/2036	(08-00S, 080-30E)	CTD (#235; 500m)
	0209/2109	(08-00S, 080-30E)	TurboMAP (#231-1; 300m)
	0226/2126	(08-00S, 080-30E)	TurboMAP (#231-2; 300m)
	0245/2145		Flux (#219)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#289)
	0437/2337	(08-00S, 080-30E)	CTD (#236; 500m),With sampling seawater
	0523/0023	(08-00S, 080-30E)	TurboMAP (#232-1; 300m)
	0539/0039	(08-00S, 080-30E)	TurboMAP (#232-2; 300m)
	0555/0055		Flux (#220)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#290)
	0739/0239	(08-00S, 080-30E)	CTD (#237; 500m)
	0812/0312	(08-00S, 080-30E)	TurboMAP (#233-1; 300m)
	0830/0330	(08-00S, 080-30E)	TurboMAP (#233-2; 300m)
	0847/0347		Flux (#221)
	1031/0531	(08-00S, 080-30E)	Radiosonde (#291)
	1039/0539	(08-00S, 080-30E)	CTD (#238; 1000m),With sampling seawater
	1143/0643	(08-00S, 080-30E)	TurboMAP (#234-1; 300m)
	1200/0700	(08-00S, 080-30E)	TurboMAP (#234-2; 300m)
	1220/0720		Flux (#222)
	1242/0742	(08-00S, 080-31E)	CFH Radiosonde (#008)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#292)
	1338/0838	(08-00S, 080-30E)	CTD (#239; 500m)
	1409/0909	(08-00S, 080-30E)	TurboMAP (#235-1; 300m)
	1426/0926	(07-59S, 080-30E)	TurboMAP (#235-2; 300m)
	1450/0950		Flux (#223)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#293)
	1639/1139	(08-00S, 080-30E)	CTD (#240; 500m),With sampling seawater
	1724/1224	(08-00S, 080-30E)	TurboMAP (#236-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#236-2; 300m)
	1800/1300		Flux (#224)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#294)
	1939/1439	(08-00S, 080-30E)	CTD (#241; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#237-1; 300m)
	2028/1528	(08-00S, 080-30E)	TurboMAP (#237-2; 300m)
	2052/1552	(08-00S, 080-30E)	Sea skater collection (#023-1)
	2111/1611	(08-00S, 080-30E)	Sea skater collection (#023-2)
	2131/1631	(08-00S, 080-31E)	Sea skater collection (#023-3)
	2150/1650		Flux (#225)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#295)

	2237/1737	(08-00S, 080-30E)	CTD (#242; 500m),With sampling seawater
	2324/1824	(08-00S, 080-30E)	TurboMAP (#238-1; 300m)
	2341/1841	(08-00S, 080-30E)	TurboMAP (#238-2; 300m)
6	0002/1902		Flux (#226)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#296)
	0136/2036	(08-00S, 080-30E)	CTD (#243; 500m)
	0210/2110	(08-00S, 080-30E)	TurboMAP (#239-1; 300m)
	0228/2128	(08-00S, 080-30E)	TurboMAP (#239-2; 300m)
	0247/2147		Flux (#227)
	0431/2331	(08-00S, 080-30E)	Radiosonde (#297)
	0438/2338	(08-00S, 080-30E)	CTD (#244; 500m),With sampling seawater
	0526/0026	(08-00S, 080-30E)	TurboMAP (#240-1; 300m)
	0542/0042	(08-00S, 080-30E)	TurboMAP (#240-2; 300m)
	0600/0100		Flux (#228)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#298)
	0739/0239	(08-00S, 080-30E)	TurboMAP (#241-1; 300m)
	0758/0258	(08-00S, 080-30E)	TurboMAP (#241-2; 300m)
	0827/0327	(08-00S, 080-30E)	CTD (#245; 500m)
	0855/0355		Flux (#229)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#299)
	1039/0539	(08-00S, 080-30E)	CTD (#246; 1000m),With sampling seawater
	1140/0640	(08-00S, 080-30E)	TurboMAP (#242-1; 300m)
	1159/0659	(08-60S, 080-30E)	TurboMAP (#242-2; 300m)
	1220/0720		Flux (#230)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#300)
	1340/0840	(08-00S, 080-30E)	CTD (#247; 500m)
	1411/0911	(08-00S, 080-30E)	TurboMAP (#243-1; 300m)
	1429/0929	(08-00S, 080-30E)	TurboMAP (#243-2; 300m)
	1447/0947		Flux (#231)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#301)
	1638/1138	(08-00S, 080-30E)	CTD (#248; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#244-1; 300m)
	1740/1240	(08-00S, 080-30E)	TurboMAP (#244-2; 300m)
	1800/1300		Flux (#232)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#302)
	1939/1439	(08-00S, 080-30E)	CTD (#249; 500m)
	2013/1513	(08-00S, 080-30E)	TurboMAP (#245-1; 300m)
	2029/1529	(08-00S, 080-30E)	TurboMAP (#245-2; 300m)
	2053/1553	(08-00S, 080-30E)	Sea skater collection (#024-1)
	2112/1612	(08-00S, 080-30E)	Sea skater collection (#024-2)
	2132/1632	(08-00S, 080-31E)	Sea skater collection (#024-3)
	2150/1650		Flux (#233)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#303)
	2236/1736	(08-00S, 080-30E)	CTD (#250; 500m),With sampling seawater
	2324/1824	(08-00S, 080-30E)	TurboMAP (#246-1; 300m)
	2341/1841	(08-00S, 080-30E)	TurboMAP (#246-2; 300m)
7	0002/1902		Flux (#234)
	0051/1951	(07-59S, 080-31E)	CFH Radiosonde (#009)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#304)
	0135/2035	(08-00S, 080-30E)	CTD (#251; 500m)
	0208/2108	(08-00S, 080-30E)	TurboMAP (#247-1; 300m)
	0227/2127	(08-00S, 080-30E)	TurboMAP (#247-2; 300m)
	0247/2147		Flux (#235)
	0430/2340	(08-00S, 080-30E)	Radiosonde (#305)
	0437/2347	(08-00S, 080-30E)	CTD (#252; 500m),With sampling seawater
	0521/0021	(08-00S, 080-30E)	TurboMAP (#248-1; 300m)
	0537/0037	(08-00S, 080-30E)	TurboMAP (#248-2; 300m)
	0555/0055		Flux (#236)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#306)
	0740/0240	(08-00S, 080-30E)	CTD (#253; 500m)
	0813/0313	(08-00S, 080-30E)	TurboMAP (#249-1; 300m)

	0831/0331	(08-00S, 080-30E)	TurboMAP (#249-2; 300m)
	0850/0350		Flux (#237)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#307)
	1039/0539	(08-00S, 080-30E)	CTD (#254; 1000m),With sampling seawater
	1140/0640	(08-00S, 080-30E)	TurboMAP (#250-1; 300m)
	1158/0658	(08-00S, 080-30E)	TurboMAP (#250-2; 300m)
	1218/0718		Flux (#238)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#308)
	1339/0839	(08-00S, 080-30E)	CTD (#255; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#251-1; 300m)
	1427/0927	(08-00S, 080-30E)	TurboMAP (#251-2; 300m)
	1447/0947		Flux (#239)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#309)
	1638/1138	(08-00S, 080-30E)	CTD (#256; 500m),With sampling seawater
	1724/1224	(08-00S, 080-30E)	TurboMAP (#252-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#252-2; 300m)
	1800/1300		Flux (#240)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#310)
	1939/1439	(08-00S, 080-30E)	CTD (#257; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#253-1; 300m)
	2028/1528	(08-00S, 080-30E)	TurboMAP (#253-2; 300m)
	2048/1548		Flux (#241)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#311)
	2237/1737	(08-00S, 080-30E)	CTD (#258; 500m),With sampling seawater
	2323/1823	(08-00S, 080-30E)	TurboMAP (#254-1; 300m)
	2343/1843	(08-00S, 080-30E)	TurboMAP (#254-2; 300m)
8	0004/1904		Flux (#242)
	0102/2002	(08-00S, 080-31E)	CFH Radiosonde (#010)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#312)
	0135/2035	(08-00S, 080-30E)	CTD (#259; 500m)
	0208/2108	(08-00S, 080-30E)	TurboMAP (#255-1; 300m)
	0227/2127	(08-00S, 080-30E)	TurboMAP (#255-2; 300m)
	0247/2147		Flux (#243)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#313)
	0436/2336	(08-00S, 080-30E)	CTD (#260; 500m),With sampling seawater
	0521/0021	(08-00S, 080-30E)	TurboMAP (#256-1; 300m)
	0536/0036	(08-60S, 080-30E)	TurboMAP (#256-2; 300m)
	0555/0055		Flux (#244)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#314)
	0740/0240	(08-00S, 080-30E)	CTD (#261; 500m)
	0813/0313	(08-00S, 080-30E)	TurboMAP (#257-1; 300m)
	0829/0329	(08-00S, 080-30E)	TurboMAP (#257-2; 300m)
	0845/0345		Flux (#245)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#315)
	1040/0540	(08-00S, 080-30E)	CTD (#262; 1000m),With sampling seawater
	1141/0641	(08-00S, 080-30E)	TurboMAP (#258-1; 300m)
	1200/0700	(07-59S, 080-30E)	TurboMAP (#258-2; 300m)
	1220/0720		Flux (#246)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#316)
	1338/0838	(08-00S, 080-30E)	CTD (#263; 500m)
	1409/0909	(08-00S, 080-30E)	TurboMAP (#259-1; 300m)
	1426/0926	(08-00S, 080-29E)	TurboMAP (#259-2; 300m)
	1446/0946		Flux (#247)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#317)
	1638/1138	(08-00S, 080-30E)	CTD (#264; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#260-1; 300m)
	1740/1240	(08-00S, 080-30E)	TurboMAP (#260-2; 300m)
	1800/1300		Flux (#248)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#318)
	1938/1438	(08-00S, 080-30E)	CTD (#265; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#261-1; 300m)

	2028/1528	(08-00S, 080-30E)	TurboMAP (#261-2; 300m)
	2051/1551	(08-00S, 080-30E)	Sea skater collection (#025-1)
	2110/1610	(08-00S, 080-31E)	Sea skater collection (#025-2)
	2130/1630	(08-00S, 080-31E)	Sea skater collection (#025-3)
	2148/1648		Flux (#249)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#319)
	2236/1736	(08-00S, 080-30E)	CTD (#266; 500m),With sampling seawater
	2323/1823	(08-00S, 080-30E)	TurboMAP (#262-1; 300m)
	2341/1841	(08-00S, 080-30E)	TurboMAP (#262-2; 300m)
9	0001/1901		Flux (#250)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#320)
	0137/2037	(08-00S, 080-30E)	CTD (#267; 500m)
	0210/2110	(08-00S, 080-30E)	TurboMAP (#263-1; 300m)
	0227/2127	(08-00S, 080-30E)	TurboMAP (#263-2; 300m)
	0247/2147		Flux (#251)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#321)
	0437/2347	(08-00S, 080-30E)	CTD (#268; 500m),With sampling seawater
	0523/0023	(08-00S, 080-30E)	TurboMAP (#264-1; 300m)
	0539/0039	(08-00S, 080-30E)	TurboMAP (#264-2; 300m)
	0557/0057		Flux (#252)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#322)
	0739/0239	(08-00S, 080-30E)	CTD (#269; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#265-1; 300m)
	0829/0329	(08-00S, 080-30E)	TurboMAP (#265-2; 300m)
	0850/0350		Flux (#253)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#323)
	1038/0538	(08-00S, 080-30E)	CTD (#270; 1000m),With sampling seawater
	1140/0640	(08-00S, 080-30E)	TurboMAP (#266-1; 300m)
	1202/0712	(08-00S, 080-30E)	TurboMAP (#266-2; 300m)
	1224/0724		Flux (#254)
	1331/0831	(08-00S, 080-30E)	Radiosonde (#324)
	1338/0838	(08-00S, 080-30E)	CTD (#271; 500m)
	1409/0909	(08-00S, 080-30E)	TurboMAP (#267-1; 300m)
	1426/0926	(08-00S, 080-29E)	TurboMAP (#267-2; 300m)
	1446/0946		Flux (#255)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#325)
	1638/1138	(08-00S, 080-30E)	CTD (#272; 500m),With sampling seawater
	1724/1224	(08-00S, 080-30E)	TurboMAP (#268-1; 300m)
	1740/1240	(08-00S, 080-30E)	TurboMAP (#268-2; 300m)
	1800/1300		Flux (#256)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#326)
	1939/1439	(08-00S, 080-30E)	CTD (#273; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#269-1; 300m)
	2028/1528	(08-00S, 080-30E)	TurboMAP (#269-2; 300m)
	2052/1552	(08-00S, 080-30E)	Sea skater collection (#026-1)
	2111/1611	(08-01S, 080-30E)	Sea skater collection (#026-2)
	2131/1631	(08-01S, 080-30E)	Sea skater collection (#026-3)
	2150/1650		Flux (#257)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#327)
	2238/1738	(08-00S, 080-30E)	CTD (#274; 500m),With sampling seawater
	2325/1825	(08-00S, 080-30E)	TurboMAP (#270-1; 300m)
	2342/1842	(08-00S, 080-30E)	TurboMAP (#270-2; 300m)
10	0001/1901		Flux (#258)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#328)
	0135/2035	(08-00S, 080-30E)	CTD (#275; 500m)
	0207/2107	(08-00S, 080-30E)	TurboMAP (#271-1; 300m)
	0226/2126	(08-00S, 080-30E)	TurboMAP (#271-2; 300m)
	0246/2146		Flux (#259)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#329)
	0439/2339	(08-00S, 080-30E)	CTD (#276; 500m),With sampling seawater
	0524/0024	(08-00S, 080-30E)	TurboMAP (#272-1; 300m)

	0539/0039	(08-00S, 080-30E)	TurboMAP (#272-2; 300m)
	0556/0056		Flux (#260)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#330)
	0740/0240	(08-00S, 080-30E)	CTD (#277; 500m)
	0812/0312	(08-00S, 080-30E)	TurboMAP (#273; 300m)
	0830/0330	(08-00S, 080-30E)	TurboMAP (#273-2; 300m)
	0851/0351		Flux (#261)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#331)
	1038/0538	(08-00S, 080-30E)	CTD (#278; 1000m),With sampling seawater
	1140/0640	(08-00S, 080-30E)	TurboMAP (#274-1; 300m)
	1159/0659	(08-00S, 080-30E)	TurboMAP (#274-2; 300m)
	1220/0720		Flux (#262)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#332)
	1338/0838	(08-00S, 080-30E)	CTD (#279; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#275-1; 300m)
	1428/0928	(08-00S, 080-30E)	TurboMAP (#275-2; 300m)
	1447/0947		Flux (#263)
	1457/0957	(08-00S, 080-30E)	CFH Radiosonde (#11)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#333)
	1639/1139	(08-00S, 080-30E)	CTD (#280; 500m),With sampling seawater
	1724/1224	(08-00S, 080-30E)	TurboMAP (#276-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#276-2; 300m)
	1800/1300		Flux (#264)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#334)
	1938/1438	(08-00S, 080-30E)	CTD (#281; 500m)
	2011/1511	(08-00S, 080-29E)	TurboMAP (#277-1; 300m)
	2028/1528	(08-00S, 080-29E)	TurboMAP (#277-2; 300m)
	2047/1547		Flux (#265)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#335)
	2239/1739	(08-00S, 080-30E)	CTD (#282; 500m),With sampling seawater
	2322/1822	(08-00S, 080-30E)	TurboMAP (#278-1; 300m)
	2340/1840	(08-00S, 080-30E)	TurboMAP (#278-2; 300m)
11	0000/1900		Flux (#266)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#336)
	0135/2035	(08-00S, 080-30E)	CTD (#283; 500m)
	0207/2107	(08-00S, 080-30E)	TurboMAP (#279-1; 300m)
	0224/2124	(08-00S, 080-30E)	TurboMAP (#279-2; 300m)
	0243/2143		Flux (#267)
	0431/2331	(08-00S, 080-30E)	Radiosonde (#337)
	0438/2338	(08-00S, 080-30E)	CTD (#284; 500m),With sampling seawater
	0523/0023	(08-00S, 080-30E)	TurboMAP (#280-1; 300m)
	0540/0040	(08-00S, 080-30E)	TurboMAP (#280-2; 300m)
	0558/0058		Flux (#268)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#338)
	0738/0238	(08-00S, 080-30E)	CTD (#285; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#281-1; 300m)
	0829/0329	(08-00S, 080-30E)	TurboMAP (#281-2; 300m)
	0849/0349		Flux (#269)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#339)
	1039/0539	(08-00S, 080-30E)	CTD (#286; 1000m),With sampling seawater
	1140/0640	(08-00S, 080-30E)	TurboMAP (#282-1; 300m)
	1159/0659	(08-00S, 080-30E)	TurboMAP (#282-2; 300m)
	1220/0720		Flux (#270)
	1338/0838	(08-00S, 080-30E)	Radiosonde (#340)
	1345/0845	(08-00S, 080-30E)	CTD (#287; 500m)
	1418/0918	(08-00S, 080-30E)	TurboMAP (#283-1; 300m)
	1435/0935	(08-00S, 080-30E)	TurboMAP (#283-2; 300m)
	1445/0945		Flux (#271)
	1630/1130	(08-00S, 080-00E)	Radiosonde (#341)
	1638/1138	(08-00S, 080-30E)	CTD (#288; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#284-1; 300m)

	1741/1241	(08-00S, 080-30E)	TurboMAP (#284-2; 300m)
	1800/1300		Flux (#272)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#342)
	1939/1439	(08-00S, 080-30E)	CTD (#289; 500m)
	2012/1512	(08-00S, 080-29E)	TurboMAP (#285-1; 300m)
	2030/1530	(08-00S, 080-29E)	TurboMAP (#285-2; 300m)
	2055/1555	(08-00S, 080-30E)	Sea skater collection (#027-1)
	2114/1614	(08-00S, 080-30E)	Sea skater collection (#027-2)
	2133/1633	(08-00S, 080-30E)	Sea skater collection (#027-3)
	2152/1652		Flux (#273)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#343)
	2236/1736	(08-00S, 080-30E)	CTD (#290; 500m),With sampling seawater
	2322/1822	(08-00S, 080-30E)	TurboMAP (#286-1; 300m)
	2340/1840	(08-00S, 080-30E)	TurboMAP (#286-2; 300m)
12	0001/1901		Flux (#274)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#344)
	0136/2036	(08-00S, 080-30E)	CTD (#291; 500m)
	0210/2110	(08-00S, 080-30E)	TurboMAP (#287-1; 300m)
	0228/2128	(08-00S, 080-30E)	TurboMAP (#287-2; 300m)
	0248/2148		Flux (#275)
	0431/2331	(08-00S, 080-30E)	Radiosonde (#345)
	0438/2338	(08-00S, 080-30E)	CTD (#292; 500m),With sampling seawater
	0524/0024	(08-00S, 080-30E)	TurboMAP (#288-1; 300m)
	0540/0040	(08-00S, 080-30E)	TurboMAP (#288-2; 300m)
	0558/0058		Flux (#276)
	0731/0231	(08-00S, 080-30E)	Radiosonde (#346)
	0739/0239	(08-00S, 080-30E)	CTD (#293; 500m)
	0813/0313	(08-00S, 080-30E)	TurboMAP (#289-1; 300m)
	0828/0328	(08-00S, 080-30E)	TurboMAP (#289-2; 300m)
	0848/0348		Flux (#277)
	1031/0531	(08-00S, 080-30E)	Radiosonde (#347)
	1040/0540	(08-00S, 080-30E)	CTD (#294; 1000m),With sampling seawater
	1142/0642	(08-00S, 080-30E)	TurboMAP (#290-1; 300m)
	1159/0659	(08-00S, 080-29E)	TurboMAP (#290-2; 300m)
	1222/0722		Flux (#278)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#348)
	1340/0840	(08-00S, 080-30E)	CTD (#295; 500m)
	1411/0911	(08-00S, 080-30E)	TurboMAP (#291-1; 300m)
	1428/0928	(08-00S, 080-30E)	TurboMAP (#291-2; 300m)
	1448/0948		Flux (#279)
	1620/1120	(08-00S, 080-30E)	Radiosonde (#349)
	1633/1133	(08-00S, 080-30E)	CTD (#296; 500m),With sampling seawater
	1719/1219	(08-00S, 080-30E)	TurboMAP (#292-1; 300m)
	1736/1236	(08-00S, 080-30E)	TurboMAP (#292-2; 300m)
	1756/1256		Flux (#280)
	1931/1431	(08-00S, 080-30E)	Radiosonde (#350)
	1939/1439	(08-00S, 080-30E)	CTD (#297; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#293-1; 300m)
	2028/1528	(08-00S, 080-30E)	TurboMAP (#293-2; 300m)
	2052/1552	(08-00S, 080-30E)	Sea skater collection (#028-1)
	2111/1611	(08-01S, 080-30E)	Sea skater collection (#028-2)
	2131/1631	(08-01S, 080-30E)	Sea skater collection (#028-3)
	2152/1652		Flux (#281)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#351)
	2236/1736	(08-00S, 080-30E)	CTD (#298; 500m),With sampling seawater
	2323/1823	(08-00S, 080-30E)	TurboMAP (#294-1; 300m)
	2340/1840	(08-00S, 080-30E)	TurboMAP (#294-2; 300m)
13	0003/1903		Flux (#282)
	0148/2048	(08-00S, 080-30E)	Radiosonde (#352)
	0151/2051	(08-00S, 080-30E)	CTD (#299; 500m)
	0224/2124	(08-00S, 080-30E)	TurboMAP (#295-1; 300m)

	0240/2140	(08-00S, 080-30E)	TurboMAP (#295-2; 300m)
	0300/2200		Flux (#283)
	0431/2331	(08-00S, 080-30E)	Radiosonde (#353)
	0439/2339	(08-00S, 080-30E)	CTD (#300; 500m),With sampling seawater
	0525/0025	(08-00S, 080-30E)	TurboMAP (#296-1; 300m)
	0542/0042	(08-00S, 080-30E)	TurboMAP (#296-2; 300m)
	0600/0100		Flux (#284)
	0731/0231	(08-00S, 080-30E)	Radiosonde (#354)
	0735/0235	(08-00S, 080-30E)	CTD (#301; 500m)
	0808/0308	(08-00S, 080-30E)	TurboMAP (#297-1; 300m)
	0825/0325	(08-00S, 080-30E)	TurboMAP (#297-2; 300m)
	0843/0343		Flux (#285)
	1037/0537	(08-00S, 080-30E)	Radiosonde (#355)
	1042/0542	(08-00S, 080-30E)	CTD (#302; 1000m),With sampling seawater
	1143/0643	(08-00S, 080-30E)	TurboMAP (#298-1; 300m)
	1200/0700	(08-00S, 080-30E)	TurboMAP (#298-2; 300m)
	1222/0722		Flux (#286)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#356)
	1334/0834	(08-00S, 080-30E)	CTD (#303; 500m)
	1406/0906	(08-00S, 080-30E)	TurboMAP (#299-1; 300m)
	1423/0923	(08-00S, 080-30E)	TurboMAP (#299-2; 300m)
	1445/0945		Flux (#287)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#357)
	1637/1137	(08-00S, 080-30E)	CTD (#304; 500m),With sampling seawater
	1722/1222	(08-00S, 080-30E)	TurboMAP (#300-1; 300m)
	1739/1239	(07-59S, 080-30E)	TurboMAP (#300-2; 300m)
	1800/1300		Flux (#288)
	1939/1439	(08-00S, 080-00E)	Radiosonde (#358)
	1943/1443	(08-00S, 080-30E)	CTD (#305; 500m)
	2015/1515	(08-00S, 080-30E)	TurboMAP (#301-1; 300m)
	2033/1533	(08-00S, 080-30E)	TurboMAP (#301-2; 300m)
	2052/1552		Flux (#289)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#359)
	2236/1736	(08-00S, 080-30E)	CTD (#306; 500m),With sampling seawater
	2324/1824	(08-00S, 080-30E)	TurboMAP (#302-1; 300m)
	2342/1842	(08-00S, 080-30E)	TurboMAP (#302-2; 300m)
14	0003/1903		Flux (#290)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#360)
	0135/2035	(08-00S, 080-30E)	CTD (#307; 500m)
	0204/2104	(08-00S, 080-30E)	TurboMAP (#303-1; 300m)
	0227/2127	(08-00S, 080-30E)	TurboMAP (#303-2; 300m)
	0247/2147		Flux (#291)
	0430/2330	(08-00S, 080-00E)	Radiosonde (#361)
	0437/2337	(08-00S, 080-30E)	CTD (#308; 500m),With sampling seawater
	0524/0024	(08-00S, 080-30E)	TurboMAP (#304-1; 300m)
	0541/0041	(08-00S, 080-29E)	TurboMAP (#304-2; 300m)
	0558/0058		Flux (#292)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#362)
	0737/0237	(08-00S, 080-30E)	CTD (#309; 500m)
	0810/0310	(08-00S, 080-30E)	TurboMAP (#305-1; 300m)
	0826/0326	(08-00S, 080-30E)	TurboMAP (#305-2; 300m)
	0845/0345		Flux (#293)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#363)
	1037/0537	(08-00S, 080-30E)	CTD (#310; 1000m),With sampling seawater
	1138/0638	(08-00S, 080-30E)	TurboMAP (#306-1; 300m)
	1156/0656	(08-00S, 080-29E)	TurboMAP (#306-2; 300m)
	1216/0716		Flux (#294)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#364)
	1337/0837	(08-00S, 080-30E)	CTD (#311; 500m)
	1409/0909	(08-00S, 080-29E)	TurboMAP (#307-1; 300m)
	1426/0926	(08-00S, 080-29E)	TurboMAP (#307-2; 300m)

	1450/0950		Flux (#295)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#365)
	1637/1137	(08-00S, 080-30E)	CTD (#312; 500m),With sampling seawater
	1724/1224	(08-00S, 080-30E)	TurboMAP (#308-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#308-2; 300m)
	1801/1301		Flux (#296)
	1930/1430	(08-00S, 080-00E)	Radiosonde (#366)
	1937/1437	(08-00S, 080-30E)	CTD (#313; 500m)
	2010/1510	(08-00S, 080-30E)	TurboMAP (#309-1; 300m)
	2027/1527	(08-00S, 080-29E)	TurboMAP (#309-2; 300m)
	2051/1551	(08-00S, 080-29E)	Sea skater collection (#029-1)
	2110/1610	(08-00S, 080-29E)	Sea skater collection (#029-2)
	2130/1630	(08-00S, 080-29E)	Sea skater collection (#029-3)
	2149/1649		Flux (#297)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#367)
	2237/1737	(08-00S, 080-30E)	CTD (#314; 500m),With sampling seawater
	2337/1837	(08-00S, 080-29E)	TurboMAP (#310-1; 300m)
	2354/1854	(08-00S, 080-29E)	TurboMAP (#310-2; 300m)
15	0016/1916		Flux (#298)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#368)
	0138/2038	(08-00S, 080-30E)	CTD (#315; 500m)
	0211/2111	(08-00S, 080-30E)	TurboMAP (#311-1; 300m)
	0230/2130	(08-00S, 080-30E)	TurboMAP (#311-2; 300m)
	0252/2152		Flux (#299)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#369)
	0437/2337	(08-00S, 080-30E)	CTD (#316; 500m),With sampling seawater
	0524/0024	(08-00S, 080-30E)	TurboMAP (#312-1; 300m)
	0539/0039	(08-00S, 080-30E)	TurboMAP (#312-2; 300m)
	0557/0057		Flux (#300)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#370)
	0738/0238	(08-00S, 080-30E)	CTD (#317; 500m)
	0812/0312	(08-00S, 080-30E)	TurboMAP (#313-1; 300m)
	0829/0329	(08-00S, 080-30E)	TurboMAP (#313-2; 300m)
	0849/0349		Flux (#301)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#371)
	1037/0537	(08-00S, 080-30E)	CTD (#318; 1000m),With sampling seawater
	1139/0639	(08-00S, 080-30E)	TurboMAP (#314-1; 300m)
	1157/0657	(08-00S, 080-29E)	TurboMAP (#314-2; 300m)
	1218/0718		Flux (#302)
	1251/0751	(08-01S, 080-30E)	CFH Radiosonde (#12)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#372)
	1338/0838	(08-00S, 080-30E)	CTD (#319; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#315-1; 300m)
	1427/0927	(08-00S, 080-30E)	TurboMAP (#315-2; 300m)
	1447/0947		Flux (#303)
	1632/1132	(08-00S, 080-30E)	Radiosonde (#373)
	1639/1139	(08-00S, 080-30E)	CTD (#320; 500m),With sampling seawater
	1726/1226	(08-00S, 080-30E)	TurboMAP (#316-1; 300m)
	1743/1243	(08-00S, 080-30E)	TurboMAP (#316-2; 300m)
	1803/1303		Flux (#304)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#374)
	1937/1437	(08-00S, 080-30E)	CTD (#321; 500m)
	2010/1510	(08-00S, 080-30E)	TurboMAP (#317-1; 300m)
	2027/1527	(08-00S, 080-30E)	TurboMAP (#317-2; 300m)
	2051/1551	(08-00S, 080-30E)	Sea skater collection (#030-1)
	2112/1612	(08-00S, 080-30E)	Sea skater collection (#030-2)
	2131/1631	(08-01S, 080-31E)	Sea skater collection (#030-3)
	2150/1650		Flux (#305)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#375)
	2237/1737	(08-00S, 080-30E)	CTD (#322; 500m),With sampling seawater
	2318/1818	(08-00S, 080-30E)	TurboMAP (#318-1; 300m)

	2341/1841	(08-00S, 080-30E)	TurboMAP (#318-2; 300m)
16	0001/1901		Flux (#306)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#376)
	0138/2038	(08-00S, 080-30E)	CTD (#323; 500m)
	0211/2111	(08-00S, 080-30E)	TurboMAP (#319-1; 300m)
	0227/2127	(08-00S, 080-30E)	TurboMAP (#319-2; 300m)
	0246/2146		Flux (#307)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#377)
	0438/2338	(08-00S, 080-30E)	CTD (#324; 500m),With sampling seawater
	0524/0024	(08-00S, 080-30E)	TurboMAP (#320-1; 300m)
	0539/0039	(08-00S, 080-30E)	TurboMAP (#320-2; 300m)
	0600/0100		Flux (#308)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#378)
	0737/0237	(08-00S, 080-30E)	CTD (#325; 500m)
	0810/0310	(08-00S, 080-30E)	TurboMAP (#321-1; 300m)
	0826/0326	(08-00S, 080-30E)	TurboMAP (#321-2; 300m)
	0845/0345		Flux (#309)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#379)
	1037/0537	(08-00S, 080-30E)	CTD (#326; 1000m),With sampling seawater
	1138/0638	(08-00S, 080-30E)	TurboMAP (#322-1; 300m)
	1156/0656	(08-00S, 080-29E)	TurboMAP (#322-2; 300m)
	1216/0716		Flux (#310)
	1247/0747	(08-00S, 080-30E)	CFH Radiosonde (#13)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#380)
	1337/0837	(08-00S, 080-30E)	CTD (#327; 500m)
	1409/0909	(08-00S, 080-30E)	TurboMAP (#323-1; 300m)
	1426/0926	(08-00S, 080-30E)	TurboMAP (#323-2; 300m)
	1446/0946		Flux (#311)
	1630/1130	(08-00S, 080-25E)	Radiosonde (#381)
	1638/1138	(08-00S, 080-30E)	CTD (#328; 500m),With sampling seawater
	1725/1225	(08-00S, 080-30E)	TurboMAP (#324-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#324-2; 300m)
	1800/1300		Flux (#312)
	1931/1431	(08-00S, 080-30E)	Radiosonde (#382)
	1937/1437	(08-00S, 080-30E)	CTD (#329; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#325-1; 300m)
	2029/1529	(08-00S, 080-30E)	TurboMAP (#325-2; 300m)
	2047/1547		Flux (#313)
	2231/1731	(08-00S, 080-30E)	Radiosonde (#383)
	2237/1737	(08-00S, 080-30E)	CTD (#330; 500m),With sampling seawater
	2323/1823	(08-00S, 080-30E)	TurboMAP (#326-1; 300m)
	2339/1839	(08-00S, 080-30E)	TurboMAP (#326-2; 300m)
17	0000/1900		Flux (#314)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#384)
	0136/2036	(08-00S, 080-30E)	CTD (#331; 500m)
	0210/2110	(08-00S, 080-30E)	TurboMAP (#327-1; 300m)
	0227/2127	(08-00S, 080-30E)	TurboMAP (#327-2; 300m)
	0246/2146		Flux (#315)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#385)
	0437/2337	(08-00S, 080-30E)	CTD (#332; 500m),With sampling seawater
	0524/0024	(08-00S, 080-30E)	TurboMAP (#328-1; 300m)
	0539/0039	(08-00S, 080-30E)	TurboMAP (#328-2; 300m)
	0556/0056		Flux (#316)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#386)
	0738/0238	(08-00S, 080-30E)	CTD (#333; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#329-1; 300m)
	0828/0328	(08-00S, 080-30E)	TurboMAP (#329-2; 300m)
	0847/0347		Flux (#317)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#387)
	1037/0537	(08-00S, 080-30E)	CTD (#334; 1000m),With sampling seawater
	1140/0640	(08-00S, 080-30E)	TurboMAP (#330-1; 300m)

	1157/0657	(08-00S, 080-30E)	TurboMAP (#330-2; 300m)
	1216/0716		Flux (#318)
	1244/0744	(08-01S, 080-30E)	CFH Radiosonde (#14)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#388)
	1339/0839	(08-00S, 080-30E)	CTD (#335; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#331-1; 300m)
	1427/0927	(08-00S, 080-30E)	TurboMAP (#331-2; 300m)
	1449/0949		Flux (#319)
	1630/1130	(08-00S, 080-00E)	Radiosonde (#389)
	1636/1136	(08-00S, 080-30E)	CTD (#336; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#332-1; 300m)
	1739/1239	(08-00S, 080-30E)	TurboMAP (#332-2; 300m)
	1758/1258		Flux (#320)
	1930/1430	(08-00S, 080-00E)	Radiosonde (#390)
	1937/1437	(08-00S, 080-30E)	CTD (#337; 500m)
	2011/1511	(08-00S, 080-30E)	TurboMAP (#333-1; 300m)
	2027/1527	(08-00S, 080-30E)	TurboMAP (#333-2; 300m)
	2049/1549	(08-00S, 080-30E)	Sea skater collection (#031-1)
	2109/1609	(08-00S, 080-30E)	Sea skater collection (#031-2)
	2128/1628	(08-00S, 080-30E)	Sea skater collection (#031-3)
	2146/1646		Flux (#321)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#391)
	2237/1737	(08-00S, 080-30E)	CTD (#338; 500m),With sampling seawater
	2323/1823	(08-00S, 080-30E)	TurboMAP (#334-1; 300m)
	2341/1841	(08-00S, 080-30E)	TurboMAP (#334-2; 300m)
18	0001/1901		Flux (#322)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#392)
	0136/2036	(08-00S, 080-30E)	CTD (#339; 500m)
	0210/2110	(08-00S, 080-30E)	TurboMAP (#335-1; 300m)
	0228/2128	(08-00S, 080-30E)	TurboMAP (#335-2; 300m)
	0247/2147		Flux (#323)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#393)
	0437/2337	(08-00S, 080-30E)	CTD (#340; 500m),With sampling seawater
	0525/0025	(08-00S, 080-30E)	TurboMAP (#336-1; 300m)
	0540/0040	(08-00S, 080-30E)	TurboMAP (#336-2; 300m)
	0557/0057		Flux (#324)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#394)
	0737/0237	(08-00S, 080-30E)	CTD (#341; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#337-1; 300m)
	0829/0329	(08-00S, 080-30E)	TurboMAP (#337-2; 300m)
	0849/0349		Flux (#325)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#395)
	1038/0538	(08-00S, 080-30E)	CTD (#342; 1000m),With sampling seawater
	1138/0638	(08-00S, 080-30E)	TurboMAP (#338-1; 300m)
	1155/0655	(08-00S, 080-30E)	TurboMAP (#338-2; 300m)
	1216/0716		Flux (#326)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#396)
	1338/0838	(08-00S, 080-30E)	CTD (#343; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#339-1; 300m)
	1429/0929	(08-00S, 080-30E)	TurboMAP (#339-2; 300m)
	1449/0949		Flux (#327)
	1524/1024	(08-00S, 080-30E)	CFH Radiosonde (#15)
	1632/1132	(08-00S, 080-30E)	Radiosonde (#397)
	1638/1138	(08-00S, 080-30E)	CTD (#344; 500m),With sampling seawater
	1725/1225	(08-00S, 080-30E)	TurboMAP (#340-1; 300m)
	1742/1242	(08-00S, 080-30E)	TurboMAP (#340-2; 300m)
	1803/1303		Flux (#328)
	1930/1430	(08-00S, 080-25E)	Radiosonde (#398)
	1938/1438	(08-00S, 080-30E)	CTD (#345; 500m)
	2012/1512	(08-00S, 080-29E)	TurboMAP (#341-1; 300m)
	2028/1528	(08-00S, 080-29E)	TurboMAP (#341-2; 300m)

	2053/1553	(08-00S, 080-29E)	Sea skater collection (#032-1)
	2113/1613	(08-00S, 080-29E)	Sea skater collection (#032-2)
	2143/1643	(08-01S, 080-29E)	Sea skater collection (#032-3)
	2202/1702		Flux (#329)
	2236/1736	(08-00S, 080-30E)	Radiosonde (#399)
	2243/1743	(08-00S, 080-30E)	CTD (#346; 500m),With sampling seawater
	2331/1831	(08-30S, 080-30E)	TurboMAP (#342-1; 300m)
	2348/1848	(08-00S, 080-30E)	TurboMAP (#342-2; 300m)
19	0010/1910		Flux (#330)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#400)
	0137/2037	(08-00S, 080-30E)	CTD (#347; 500m)
	0211/2111	(08-00S, 080-30E)	TurboMAP (#343-1; 300m)
	0230/2130	(08-00S, 080-30E)	TurboMAP (#343-2; 300m)
	0251/2151		Flux (#331)
	0430/2330	(08-00S, 080-00E)	Radiosonde (#401)
	0438/2338	(08-00S, 080-30E)	CTD (#348; 500m),With sampling seawater
	0525/0025	(08-00S, 080-30E)	TurboMAP (#344-1; 300m)
	0540/0040	(08-00S, 080-29E)	TurboMAP (#344-2; 300m)
	0557/0057		Flux (#332)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#402)
	0740/0240	(08-00S, 080-30E)	CTD (#349; 500m)
	0815/0315	(08-00S, 080-30E)	TurboMAP (#345-1; 300m)
	0834/0334	(08-00S, 080-30E)	TurboMAP (#345-2; 300m)
	0856/0356		Flux (#333)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#403)
	1037/0537	(08-00S, 080-30E)	Radiosonde (#M005)
	1038/0538	(08-00S, 080-30E)	CTD (#350; 1000m),With sampling seawater
	1142/0642	(08-00S, 080-30E)	TurboMAP (#346-1; 300m)
	1200/0700	(08-00S, 080-29E)	TurboMAP (#346-2; 300m)
	1225/0725		Flux (#334)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#404)
	1338/0838	(08-00S, 080-30E)	CTD (#351; 500m)
	1411/0911	(08-00S, 080-29E)	TurboMAP (#347-1; 300m)
	1430/0930	(08-00S, 080-29E)	TurboMAP (#347-2; 300m)
	1451/0951		Flux (#335)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#405)
	1637/1137	(08-00S, 080-30E)	CTD (#352; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#348-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#348-2; 300m)
	1801/1301		Flux (#336)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#406)
	1938/1438	(08-00S, 080-30E)	CTD (#353; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#349-1; 300m)
	2029/1529	(08-00S, 080-30E)	TurboMAP (#349-2; 300m)
	2047/1547		Flux (#337)
	2231/1731	(08-00S, 080-30E)	Radiosonde (#407)
	2241/1741	(08-00S, 080-30E)	CTD (#354; 500m),With sampling seawater
	2329/1829	(08-30S, 080-29E)	TurboMAP (#350-1; 300m)
	2347/1847	(08-00S, 080-29E)	TurboMAP (#350-2; 300m)
20	0008/1908		Flux (#338)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#408)
	0136/2036	(08-00S, 080-30E)	CTD (#355; 500m)
	0210/2110	(08-00S, 080-30E)	TurboMAP (#351-1; 300m)
	0228/2128	(08-00S, 080-30E)	TurboMAP (#351-2; 300m)
	0250/2150		Flux (#339)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#409)
	0437/2337	(08-00S, 080-30E)	CTD (#356; 500m),With sampling seawater
	0524/0024	(08-00S, 080-30E)	TurboMAP (#352-1; 300m)
	0539/0039	(08-00S, 080-30E)	TurboMAP (#352-2; 300m)
	0556/0056		Flux (#340)
	0730/0230	(08-00S, 080-31E)	Radiosonde (#410)

	0739/0239	(08-00S, 080-31E)	CTD (#357; 500m)
	0813/0313	(08-00S, 080-30E)	TurboMAP (#353-1; 300m)
	0828/0328	(08-00S, 080-30E)	TurboMAP (#353-2; 300m)
	0847/0347		Flux (#341)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#411)
	1037/0537	(08-00S, 080-30E)	CTD (#358; 1000m),With sampling seawater
	1139/0639	(08-00S, 080-30E)	TurboMAP (#354-1; 300m)
	1157/0657	(08-00S, 080-30E)	TurboMAP (#354-2; 300m)
	1218/0728		Flux (#342)
	1245/0745	(08-00S, 080-31E)	CFH Radiosonde (#16)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#412)
	1337/0837	(08-00S, 080-30E)	CTD (#359; 500m)
	1409/0909	(08-00S, 080-30E)	TurboMAP (#355-1; 300m)
	1427/0927	(08-00S, 080-30E)	TurboMAP (#355-2; 300m)
	1450/0950		Flux (#343)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#413)
	1636/1136	(08-00S, 080-30E)	CTD (#360; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#356-1; 300m)
	1741/1241	(08-00S, 080-30E)	TurboMAP (#356-2; 300m)
	1801/1301		Flux (#344)
	1934/1434	(08-00S, 080-00E)	Radiosonde (#414)
	1941/1441	(08-00S, 080-30E)	CTD (#361; 500m)
	2015/1515	(08-00S, 080-30E)	TurboMAP (#357-1; 300m)
	2030/1530	(08-00S, 080-30E)	TurboMAP (#357-2; 300m)
	2053/1553	(08-00S, 080-30E)	Sea skater collection (#033-1)
	2113/1613	(08-00S, 080-30E)	Sea skater collection (#033-2)
	2132/1632	(08-01S, 080-30E)	Sea skater collection (#033-3)
	2151/1651		Flux (#345)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#415)
	2232/1732	(08-00S, 080-30E)	Radiosonde (#M006)
	2238/1738	(08-00S, 080-30E)	CTD (#362; 500m),With sampling seawater
	2326/1826	(08-00S, 080-30E)	TurboMAP (#358-1; 300m)
	2343/1843	(08-00S, 080-30E)	TurboMAP (#358-2; 300m)
21	0005/1905		Flux (#346)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#416)
	0136/2036	(08-00S, 080-30E)	CTD (#363; 500m)
	0211/2111	(08-00S, 080-30E)	TurboMAP (#359-1; 300m)
	0229/2129	(08-00S, 080-30E)	TurboMAP (#359-2; 300m)
	0248/2148		Flux (#347)
	0430/2330	(08-00S, 080-00E)	Radiosonde (#417)
	0437/2337	(08-00S, 080-30E)	CTD (#364; 500m),With sampling seawater
	0525/0025	(08-00S, 080-30E)	TurboMAP (#360-1; 300m)
	0540/0040	(08-00S, 080-30E)	TurboMAP (#360-2; 300m)
	0557/0057		Flux (#348)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#418)
	0736/0236	(08-00S, 080-30E)	CTD (#365; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#361-1; 300m)
	0828/0328	(08-00S, 080-30E)	TurboMAP (#361-2; 300m)
	0848/0348		Flux (#349)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#419)
	1037/0537	(08-00S, 080-30E)	CTD (#366; 1000m),With sampling seawater
	1139/0639	(08-00S, 080-30E)	TurboMAP (#362-1; 300m)
	1157/0657	(08-00S, 080-30E)	TurboMAP (#362-2; 300m)
	1218/0718		Flux (#350)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#420)
	1337/0837	(08-00S, 080-30E)	CTD (#367; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#363-1; 300m)
	1427/0927	(08-00S, 080-30E)	TurboMAP (#363-2; 300m)
	1448/0948		Flux (#351)
	1454/0954	(08-00S, 080-30E)	CFH Radiosonde (#17)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#421)

	1636/1136	(08-00S, 080-30E)	CTD (#368; 500m),With sampling seawater
	1722/1222	(08-00S, 080-30E)	TurboMAP (#364-1; 300m)
	1739/1239	(08-00S, 080-30E)	TurboMAP (#364-2; 300m)
	1800/1300		Flux (#352)
	1935/1435	(08-00S, 080-30E)	Radiosonde (#422)
	1940/1440	(08-00S, 080-30E)	CTD (#369; 500m)
	2013/1513	(08-00S, 080-30E)	TurboMAP (#365-1; 300m)
	2029/1529	(08-00S, 080-30E)	TurboMAP (#365-2; 300m)
	2051/1551	(08-00S, 080-30E)	Sea skater collection (#034-1)
	2111/1611	(08-00S, 080-30E)	Sea skater collection (#034-2)
	2130/1630	(08-00S, 080-30E)	Sea skater collection (#034-3)
	2149/1649		Flux (#353)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#423)
	2239/1739	(08-00S, 080-30E)	CTD (#370; 500m),With sampling seawater
	2324/1824	(08-00S, 080-30E)	TurboMAP (#366-1; 300m)
	2342/1842	(08-00S, 080-29E)	TurboMAP (#366-2; 300m)
22	0001/1901		Flux (#354)
	0131/2031	(08-00S, 080-30E)	Radiosonde (#424)
	0138/2038	(08-00S, 080-30E)	CTD (#371; 500m)
	0212/2112	(08-00S, 080-30E)	TurboMAP (#367-1; 300m)
	0230/2130	(08-00S, 080-30E)	TurboMAP (#367-2; 300m)
	0250/2150		Flux (#355)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#425)
	0436/2336	(08-00S, 080-30E)	CTD (#372; 500m),With sampling seawater
	0521/0021	(08-00S, 080-30E)	TurboMAP (#368-1; 300m)
	0536/0036	(08-00S, 080-30E)	TurboMAP (#368-2; 300m)
	0555/0055		Flux (#356)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#426)
	0737/0237	(08-00S, 080-30E)	CTD (#373; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#369-1; 300m)
	0825/0325	(08-00S, 080-30E)	TurboMAP (#369-2; 300m)
	0843/0343		Flux (#357)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#427)
	1038/0538	(08-00S, 080-30E)	CTD (#374; 1000m),With sampling seawater
	1138/0638	(08-00S, 080-30E)	TurboMAP (#370-1; 300m)
	1155/0655	(08-00S, 080-30E)	TurboMAP (#370-2; 300m)
	1215/0715		Flux (#358)
	1242/0742	(08-00S, 080-30E)	CFH Radiosonde (#18)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#428)
	1337/0837	(08-00S, 080-30E)	CTD (#375; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#371-1; 300m)
	1427/0927	(08-00S, 080-30E)	TurboMAP (#371-2; 300m)
	1446/0946		Flux (#359)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#429)
	1636/1136	(08-00S, 080-30E)	CTD (#376; 500m),With sampling seawater
	1722/1222	(08-00S, 080-30E)	TurboMAP (#372-1; 300m)
	1739/1239	(08-00S, 080-29E)	TurboMAP (#372-2; 300m)
	1758/1258		Flux (#360)
	1931/1431	(08-00S, 080-30E)	Radiosonde (#430)
	1937/1437	(08-00S, 080-30E)	CTD (#377; 500m)
	2010/1510	(08-00S, 080-29E)	TurboMAP (#373-1; 300m)
	2026/1526	(08-00S, 080-29E)	TurboMAP (#373-2; 300m)
	2045/1545		Flux (#361)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#431)
	2236/1736	(08-00S, 080-30E)	CTD (#378; 500m),With sampling seawater
	2324/1824	(08-00S, 080-30E)	TurboMAP (#374-1; 300m)
	2344/1844	(08-00S, 080-30E)	TurboMAP (#374-2; 300m)
23	0005/1905		Flux (#362)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#432)
	0138/2038	(08-00S, 080-30E)	CTD (#379; 500m)
	0213/2113	(08-00S, 080-30E)	TurboMAP (#375-1; 300m)

	0231/2131	(08-00S, 080-30E)	TurboMAP (#375-2; 300m)
	0255/2155		Flux (#363)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#433)
	0439/2339	(08-00S, 080-30E)	CTD (#380; 500m),With sampling seawater
	0525/0025	(08-00S, 080-30E)	TurboMAP (#376-1; 300m)
	0540/0040	(08-00S, 080-30E)	TurboMAP (#376-2; 300m)
	0558/0058		Flux (#364)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#434)
	0737/0237	(08-00S, 080-30E)	CTD (#381; 500m)
	0810/0310	(08-00S, 080-30E)	TurboMAP (#377-1; 300m)
	0825/0325	(08-00S, 080-30E)	TurboMAP (#377-2; 300m)
	0843/0343		Flux (#365)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#435)
	1037/0537	(08-00S, 080-30E)	CTD (#382; 1000m),With sampling seawater
	1138/0638	(08-00S, 080-30E)	TurboMAP (#378-1; 300m)
	1156/0656	(08-00S, 080-30E)	TurboMAP (#378-2; 300m)
	1217/0717		Flux (#366)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#436)
	1337/0837	(08-00S, 080-30E)	CTD (#383; 500m)
	1411/0911	(08-00S, 080-30E)	TurboMAP (#379-1; 300m)
	1429/0929	(08-00S, 080-30E)	TurboMAP (#379-2; 300m)
	1450/0950		Flux (#367)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#437)
	1636/1136	(08-00S, 080-30E)	CTD (#384; 500m),With sampling seawater
	1721/1221	(08-00S, 080-30E)	TurboMAP (#380-1; 300m)
	1739/1239	(08-00S, 080-30E)	TurboMAP (#380-2; 300m)
	1800/1300		Flux (#368)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#438)
	1937/1437	(08-00S, 080-30E)	CTD (#385; 500m)
	2010/1510	(08-00S, 080-30E)	TurboMAP (#381-1; 300m)
	2025/1525	(08-00S, 080-30E)	TurboMAP (#381-2; 300m)
	2049/1549	(08-00S, 080-30E)	Sea skater collection (#035-1)
	2109/1609	(08-01S, 080-30E)	Sea skater collection (#035-2)
	2128/1628	(08-01S, 080-30E)	Sea skater collection (#035-3)
	2147/1647		Flux (#369)
	2231/1731	(08-00S, 080-30E)	Radiosonde (#439)
	2237/1737	(08-00S, 080-30E)	CTD (#386; 500m),With sampling seawater
	2325/1825	(08-00S, 080-30E)	TurboMAP (#382-1; 300m)
	2342/1842	(08-00S, 080-29E)	TurboMAP (#382-2; 300m)
24	0002/1902		Flux (#370)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#440)
	0138/2038	(08-00S, 080-30E)	CTD (#387; 500m)
	0213/2113	(08-00S, 080-30E)	TurboMAP (#383-1; 300m)
	0230/2130	(08-00S, 080-30E)	TurboMAP (#383-2; 300m)
	0252/2152		Flux (#371)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#441)
	0437/2337	(08-00S, 080-30E)	CTD (#388; 500m),With sampling seawater
	0523/0023	(08-00S, 080-30E)	TurboMAP (#384-1; 300m)
	0537/0037	(08-00S, 080-30E)	TurboMAP (#384-2; 300m)
	0555/0055		Flux (#372)
	0744/0244	(08-00S, 080-30E)	Radiosonde (#442)
	0750/0250	(08-00S, 080-30E)	CTD (#389; 500m)
	0823/0323	(08-00S, 080-29E)	TurboMAP (#385-1; 300m)
	0838/0338	(08-00S, 080-29E)	TurboMAP (#385-2; 300m)
	0855/0355		Flux (#373)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#443)
	1338/0538	(08-00S, 080-30E)	CTD (#390; 1000m),With sampling seawater
	1148/0648	(08-00S, 080-30E)	TurboMAP (#386-1; 300m)
	1206/0706	(08-00S, 080-30E)	TurboMAP (#386-2; 300m)
	1228/0728		Flux (#374)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#444)

	1337/0837	(08-00S, 080-30E)	CTD (#391; 500m)
	1410/0910	(08-00S, 080-30E)	TurboMAP (#387-1; 300m)
	1428/0928	(08-00S, 080-30E)	TurboMAP (#387-2; 300m)
	1450/0950		Flux (#375)
	1455/0955	(08-00S, 080-30E)	CFH Radiosonde (#19)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#445)
	1637/1137	(08-00S, 080-30E)	CTD (#392; 500m),With sampling seawater
	1723/1223	(08-00S, 080-30E)	TurboMAP (#388-1; 300m)
	1742/1242	(08-00S, 080-30E)	TurboMAP (#388-2; 300m)
	1805/1305		Flux (#376)
	1931/1431	(08-00S, 080-30E)	Radiosonde (#446)
	1938/1438	(08-00S, 080-30E)	CTD (#393; 500m)
	2012/1512	(08-00S, 080-30E)	TurboMAP (#389-1; 300m)
	2027/1527	(08-00S, 080-30E)	TurboMAP (#389-2; 300m)
	2050/1550	(08-00S, 080-29E)	Sea skater collection (#036-1)
	2111/1611	(08-00S, 080-29E)	Sea skater collection (#036-2)
	2130/1630	(08-00S, 080-30E)	Sea skater collection (#036-3)
	2149/1649		Flux (#377)
	2223/1723	(08-00S, 080-30E)	Radiosonde (#447)
	2236/1736	(08-00S, 080-30E)	CTD (#394; 500m),With sampling seawater
	2328/1828	(08-00S, 080-30E)	TurboMAP (#390-1; 300m)
	2344/1844	(08-00S, 080-29E)	TurboMAP (#390-2; 300m)
25	0005/1905		Flux (#378)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#448)
	0140/2040	(08-00S, 080-30E)	CTD (#395; 500m)
	0216/2116	(08-00S, 080-30E)	TurboMAP (#391-1; 300m)
	0232/2132	(08-00S, 080-30E)	TurboMAP (#391-2; 300m)
	0252/2152		Flux (#379)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#449)
	0442/2342	(08-00S, 080-30E)	CTD (#396; 500m),With sampling seawater
	0528/0028	(08-00S, 080-30E)	TurboMAP (#392-1; 300m)
	0544/0044	(08-00S, 080-30E)	TurboMAP (#392-2; 300m)
	0605/0105		Flux (#380)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#450)
	0739/0239	(08-00S, 080-30E)	CTD (#397; 500m)
	0814/0314	(08-00S, 080-30E)	TurboMAP (#393-1; 300m)
	0831/0331	(08-00S, 080-30E)	TurboMAP (#393-2; 300m)
	0851/0351		Flux (#381)
	1031/0531	(08-00S, 080-30E)	Radiosonde (#451)
	1039/0539	(08-00S, 080-30E)	CTD (#398; 1000m),With sampling seawater
	1055/0555	(08-00S, 080-30E)	Radiosonde (#M007)
	1145/0645	(08-00S, 080-30E)	TurboMAP (#394-1; 300m)
	1203/0703	(08-00S, 080-30E)	TurboMAP (#394-2; 300m)
	1224/0724		Flux (#382)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#452)
	1338/0838	(08-00S, 080-30E)	CTD (#399; 500m)
	1414/0914	(08-00S, 080-30E)	TurboMAP (#395-1; 300m)
	1432/0932	(08-00S, 080-30E)	TurboMAP (#395-2; 300m)
	1452/0952		Flux (#383)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#453)
	1636/1136	(08-00S, 080-30E)	CTD (#400; 500m),With sampling seawater
	1722/1222	(08-00S, 080-30E)	TurboMAP (#396-1; 300m)
	1738/1238	(08-00S, 080-30E)	TurboMAP (#396-2; 300m)
	1758/1258		Flux (#384)
	1931/1431	(08-00S, 080-30E)	Radiosonde (#454)
	1935/1435	(08-00S, 080-30E)	CTD (#401; 500m)
	2013/1513	(08-00S, 080-30E)	TurboMAP (#397-1; 300m)
	2028/1528	(08-00S, 080-30E)	TurboMAP (#397-2; 300m)
	2047/1547		Flux (#385)
	2231/1731	(08-00S, 080-30E)	Radiosonde (#455)
	2239/1739	(08-00S, 080-30E)	CTD (#402; 500m),With sampling seawater

	2332/1832	(08-00S, 080-29E)	TurboMAP (#398-1; 300m)
	2355/1855	(08-00S, 080-29E)	TurboMAP (#398-2; 300m)
26	0016/1916		Flux (#386)
	0126/2026	(08-00S, 080-30E)	Radiosonde (#456)
	0131/2031	(08-00S, 080-30E)	CTD (#403; 500m)
	0206/2106	(08-00S, 080-30E)	TurboMAP (#399-1; 300m)
	0222/2122	(08-00S, 080-30E)	TurboMAP (#399-2; 300m)
	0242/2142		Flux (#387)
	0438/2338	(08-00S, 080-30E)	CTD (#404; 500m),With sampling seawater
	0458/2358	(08-00S, 080-30E)	Radiosonde (#457)
	0524/0024	(08-00S, 080-30E)	TurboMAP (#400-1; 300m)
	0541/0041	(08-00S, 080-30E)	TurboMAP (#400-2; 300m)
	0559/0059		Flux (#388)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#458)
	0736/0236	(08-00S, 080-30E)	CTD (#405; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#401-1; 300m)
	0826/0326	(08-00S, 080-30E)	TurboMAP (#401-2; 300m)
	0845/0345		Flux (#389)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#459)
	1037/0537	(08-00S, 080-30E)	CTD (#406; 1000m),With sampling seawater
	1142/0642	(08-00S, 080-30E)	TurboMAP (#402-1; 300m)
	1200/0700	(08-00S, 080-30E)	TurboMAP (#402-2; 300m)
	1221/0721		Flux (#390)
	1240/0740	(08-00S, 080-30E)	CFH Radiosonde (#20)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#460)
	1337/0837	(08-00S, 080-30E)	CTD (#407; 500m)
	1412/0912	(08-00S, 080-30E)	TurboMAP (#403-1; 300m)
	1430/0930	(08-00S, 080-30E)	TurboMAP (#403-2; 300m)
	1450/0950		Flux (#391)
	1630/1130	(08-00S, 080-30E)	Radiosonde (#461)
	1636/1136	(08-00S, 080-30E)	CTD (#408; 500m),With sampling seawater
	1722/1222	(08-00S, 080-30E)	TurboMAP (#404-1; 300m)
	1739/1239	(08-00S, 080-30E)	TurboMAP (#404-2; 300m)
	1758/1258		Flux (#392)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#462)
	1935/1435	(08-00S, 080-30E)	CTD (#409; 500m)
	2010/1510	(08-00S, 080-30E)	TurboMAP (#405-1; 300m)
	2027/1527	(08-00S, 080-30E)	TurboMAP (#405-2; 300m)
	2046/1546		Flux (#393)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#463)
	2238/1738	(08-00S, 080-30E)	CTD (#410; 500m),With sampling seawater
	2328/1828	(08-00S, 080-29E)	TurboMAP (#406-1; 300m)
	2347/1847	(08-00S, 080-29E)	TurboMAP (#406-2; 300m)
27	0005/1905		Flux (#394)
	0127/2027	(08-00S, 080-30E)	Radiosonde (#M008)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#464)
	0137/2037	(08-00S, 080-30E)	CTD (#411; 500m)
	0212/2137	(08-00S, 080-30E)	TurboMAP (#407-1; 300m)
	0230/2130	(08-00S, 080-30E)	TurboMAP (#407-2; 300m)
	0250/2150		Flux (#395)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#465)
	0439/2339	(08-00S, 080-30E)	CTD (#412; 500m),With sampling seawater
	0525/0025	(08-00S, 080-30E)	TurboMAP (#408-1; 300m)
	0540/0040	(08-00S, 080-30E)	TurboMAP (#408-2; 300m)
	0557/0057		Flux (#396)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#466)
	0737/0237	(08-00S, 080-30E)	CTD (#413; 500m)
	0812/0312	(08-00S, 080-30E)	TurboMAP (#409-1; 300m)
	0827/0327	(08-00S, 080-30E)	TurboMAP (#409-2; 300m)
	0846/0346		Flux (#397)
	1030/0530	(08-00S, 080-30E)	Radiosonde (#467)

	1037/0537	(08-00S, 080-30E)	CTD (#414; 1000m),With sampling seawater
	1142/0642	(08-00S, 080-30E)	TurboMAP (#410-1; 300m)
	1200/0700	(08-00S, 080-30E)	TurboMAP (#410-2; 300m)
	1220/0720		Flux (#398)
	1330/0830	(08-00S, 080-30E)	Radiosonde (#468)
	1337/0837	(08-00S, 080-30E)	CTD (#415; 500m)
	1411/0911	(08-00S, 080-30E)	TurboMAP (#411-1; 300m)
	1428/0928	(08-00S, 080-30E)	TurboMAP (#411-2; 300m)
	1448/0948		Flux (#399)
	1631/1131	(08-00S, 080-30E)	Radiosonde (#469)
	1637/1137	(08-00S, 080-30E)	CTD (#416; 500m),With sampling seawater
	1724/1224	(08-00S, 080-30E)	TurboMAP (#412-1; 300m)
	1740/1240	(08-00S, 080-30E)	TurboMAP (#412-2; 300m)
	1800/1300		Flux (#400)
	1930/1430	(08-00S, 080-30E)	Radiosonde (#470)
	1935/1435	(08-00S, 080-30E)	CTD (#417; 500m)
	2010/1510	(08-00S, 080-30E)	TurboMAP (#413-1; 300m)
	2026/1526	(08-00S, 080-29E)	TurboMAP (#413-2; 300m)
	2044/1544		Flux (#401)
	2229/1729	(08-00S, 080-30E)	Radiosonde (#M009)
	2230/1730	(08-00S, 080-30E)	Radiosonde (#471)
	2237/1737	(08-00S, 080-30E)	CTD (#418; 500m),With sampling seawater
	2327/1827	(08-00S, 080-30E)	TurboMAP (#414-1; 300m)
	2342/1842	(08-00S, 080-30E)	TurboMAP (#414-2; 300m)
28	0002/1902		Flux (#402)
	0130/2030	(08-00S, 080-30E)	Radiosonde (#472)
	0139/2039	(08-00S, 080-30E)	CTD (#419; 500m)
	0214/2114	(08-00S, 080-30E)	TurboMAP (#415-1; 300m)
	0230/2130	(08-00S, 080-29E)	TurboMAP (#415-2; 300m)
	0250/2150		Flux (#403)
	0430/2330	(08-00S, 080-30E)	Radiosonde (#473)
	0436/2336	(08-00S, 080-30E)	CTD (#420; 500m),With sampling seawater
	0521/0021	(08-00S, 080-30E)	TurboMAP (#416-1; 300m)
	0537/0037	(08-00S, 080-30E)	TurboMAP (#416-2; 300m)
	0553/0053		Flux (#404)
	0730/0230	(08-00S, 080-30E)	Radiosonde (#474)
	0737/0237	(08-00S, 080-30E)	CTD (#421; 500m)
	0811/0311	(08-00S, 080-30E)	TurboMAP (#417-1; 300m)
	0828/0328	(08-00S, 080-29E)	TurboMAP (#417-2; 300m)
	0847/0347		Flux (#405)
	0855/0355		Recover "Sea-Snake" SSST sensor
	1026/0526	(08-00S, 080-30E)	Radiosonde (#475)
	1036/0536	(08-00S, 080-30E)	CTD (#422; 1000m),With sampling seawater
	1103/0603	(08-00S, 080-30E)	Radiosonde (#476)
	1141/0641	(08-00S, 080-30E)	TurboMAP (#418-1; 300m)
	1158/0658	(08-00S, 080-30E)	TurboMAP (#418-2; 300m)
	1203/0703	(08-00S, 080-29E)	Radiosonde (#M010)
	1235/0735	(08-00S, 080-30E)	RAMA buoy inspection
	1330/0830	(07-52S, 080-18E)	Radiosonde (#477)
	1500/1000	(07-34S, 080-06E)	Radiosonde (#M011)
	1521/1021	(07-30S, 080-03E)	XCTD (#X01)
	1632/1132	(07-16S, 079-53E)	Radiosonde (#478)
	1759/1259	(07-00S, 079-39E)	XCTD (#X02)
	1800/1300	(07-00S, 079-38E)	Radiosonde (#M012)
	1930/1430	(06-42S, 079-24E)	Radiosonde (#479)
	2032/1532	(06-30S, 079-14E)	XCTD (#X03)
	2100/1600	(06-25S, 079-10E)	Radiosonde (#M013)
	2223/1723	(06-10S, 078-58E)	Radiosonde (#480)
	2323/1823	(06-00S, 079-39E)	XCTD (#X04)
29	0001/1901	(05-54S, 078-46E)	Radiosonde (#M014)
	0130/2030	(05-39S, 078-33E)	Radiosonde (#481)

	0225/2125	(05-30S, 078-26E)	XCTD (#X05)
	0259/2159	(05-27S, 078-22E)	Radiosonde (#M015)
	0430/2330	(05-14S, 078-13E)	Radiosonde (#482)
	0601/0101	(05-07S, 078-06E)	Radiosonde (#M016)
	0740/0240	(05-06S, 078-06E)	Radiosonde (#483)
	0809/0309	(05-06S, 078-05E)	Recover sub-surface ADCP mooring
	0901/0401	(05-06S, 078-05E)	Radiosonde (#M017)
	1030/0530	(05-07S, 078-06E)	Radiosonde (#484)
	1101/0601	(05-08S, 078-06E)	CTD (#423; 1000m)
	1203/0703	(05-08S, 078-06E)	Radiosonde (#M018)
	1330/0830	(05-05S, 078-07E)	Radiosonde (#485)
	1500/1000	(05-04S, 078-05E)	Radiosonde (#M019)
	1631/1131	(05-06S, 078-06E)	Radiosonde (#486)
	1759/1259	(05-06S, 078-08E)	Radiosonde (#M020)
	1930/1430	(05-04S, 078-06E)	Radiosonde (#487)
	2209/1709	(04-30S, 078-19E)	XCTD (#X06)
	2231/1731	(04-26S, 078-22E)	Radiosonde (#488)
30	0027/1927	(04-00S, 078-30E)	XCTD (#X07)
	0130/2030	(03-46S, 078-35E)	Radiosonde (#489)
	0239/2139	(03-30S, 078-41E)	XCTD (#X08)
	0430/2330	(03-05S, 078-52E)	Radiosonde (#490)
	0450/2350	(03-00S, 078-53E)	XCTD (#X09)
	0703/0203	(02-30S, 079-04E)	XCTD (#X10)
	0730/0230	(02-23S, 079-07E)	Radiosonde (#491)
	0913/0413	(01-59S, 079-16E)	XCTD (#X11)
	1030/0530	(01-41S, 079-22E)	Radiosonde (#492)
	1119/0619	(01-30S, 079-26E)	XCTD (#X12)
	1329/0829	(01-00S, 079-39E)	XCTD (#X13)
	1330/0830	(01-00S, 079-39E)	Radiosonde (#493)
	1540/1040	(00-30S, 079-50E)	XCTD (#X14)
	1630/1130	(00-18S, 079-54E)	Radiosonde (#494)
	1930/1430	(00-00, 080-02E)	Radiosonde (#495)
	2251/1751	(00-09N, 080-13E)	Radiosonde (#496)
Dec. 1	0130/2030	(00-44N, 080-22E)	Radiosonde (#497)
	0431/2331	(01-23N, 080-30E)	Radiosonde (#498)
	0520/0020	(01-30N, 080-30E)	RAMA buoy inspection
	0810/0310	Stop of Doppler radar observation	
	----/1700	Revision of Ship Mean Time (to UTC+5.5h)	
2	1000/0430	Arrival at Colombo, Sri Lanka	

4. List of Participants

4.1 Participants (on board)

Name	Affiliation	*Theme No.	Period on board
Kunio YONEYAMA	JAMSTEC	M	Leg-1
Masaki KATSUMATA	JAMSTEC	M	Leg-1 + 2
Kazuaki YASUNAGA	JAMSTEC	M	Leg-2
Ayako SEIKI	JAMSTEC	M	Leg-2
Chiharu TAKAHASHI	JAMSTEC	M	Leg-1
Ayumi KUROTAKI	JAMSTEC	M	Leg-1
Mariko SEKI	JAMSTEC	M	Leg-2
Momoko KIMURA	JAMSTEC	M	Leg-2
Keisuke TASHIRO	JAMSTEC	M	Leg-2
Kelvin RICHARDS	IPRC	M	Leg-1
Andrei NATAROV	IPRC	M	Leg-1 + 2
Aya TSUBOI	Kyoto Univ.	1	Leg-1
Nao TAKAMURA	Kyoto Univ.	1	Leg-1
Hirofumi UENO	Okayama Univ.	3	Leg-2
Junko SUZUKI	JAMSTEC	4	Leg-1 + 2
Tetsuya OHKURA	Chiba Univ.	5	Leg-1
Tomoaki NISHIZAWA	NIES	5+6	Leg-1
Ichiro MATSUI	NIES	5+6	Leg-2
Tetsuo HARADA	Kochi Univ.	10	Leg-1
Takero SEKIMOTO	Kochi Univ.	10	Leg-1 + 2
Yuki OSUMI	Kochi Univ.	10	Leg-1 + 2
Takashi SHIRAKI	Kochi Univ.	10	Leg-1
Akane KOBAYASHI	Kochi Univ.	10	Leg-1
Souichiro SUEYOSHI	Global Ocean Development Inc. (GODI)	T	Leg-1 + 2
Asuka DOI	GODI	T	Leg-1 + 2
Toshimitsu GOTO	GODI	T	Leg-1 + 2
Katsuhisa MAENO	GODI	T	Leg-1
Ryo KIMURA	GODI	T	Leg-1
Satoshi OKUMURA	GODI	T	Leg-1
Kazuho YOSHIDA	GODI	T	Leg-1
Satoshi OZAWA	Marine Works Japan Ltd. (MWJ)	T	Leg-1
Fujio KOBAYASHI	MWJ	T	Leg-1
Naoko MIYAMOTO	MWJ	T	Leg-1
Shungo OSHITANI	MWJ	T	Leg-1
Masanori ENOKI	MWJ	T	Leg-1
Ayaka HATSUYAMA	MWJ	T	Leg-1
Hironori SATOH	MWJ	T	Leg-1
Kanako YOSHIDA	MWJ	T	Leg-1
Yuki MIYAJIMA	MWJ	T	Leg-1

Masahiro ORUI	MWJ	T	Leg-1
Shinsuke TOYODA	MWJ	T	Leg-1
Ken'ichi KATAYAMA	MWJ	T	Leg-2
Tatsuya TANAKA	MWJ	T	Leg-2
Tomohide NOGUCHI	MWJ	T	Leg-2
Tamami UENO	MWJ	T	Leg-2
Tetsuharu NISHINO	MWJ	T	Leg-2
Minoru KAMATA	MWJ	T	Leg-2
Yasuhiro ARII	MWJ	T	Leg-2
Makoto TAKADA	MWJ	T	Leg-2
Shin'ichiro YOKOGAWA	MWJ	T	Leg-2
Miyo IKEDA	MWJ	T	Leg-2
Yasumi YAMADA	MWJ	T	Leg-2

* Theme number corresponds to that shown in Section 2.7.
M and T means main mission and technical staff, respectively.

4.2 Participants (not on board)

Name	Affiliation	*Theme No.
Tetsuya TAKEMI	Kyoto Univ.	1
Taro SHINODA	Nagoya Univ.	2
Osamu TSUKAMOTO	Okayama Univ.	3
Masatomo FUJIWARA	Hokkaido Univ.	4
Toshiaki TAKANO	Chiba Univ.	5
Nobuo SUGIMOTO	NIES	6
Kazuma AOKI	Toyama Univ.	7
Hisahiro TAKASHIMA	JAMSTEC	8
Naoyuki KURITA	JAMSTEC	9
Chihiro KATAGIRI	Hokkaido Univ.	10
Takeshi MATSUMOTO	Ryukyu Univ.	11

4.3 Ship Crew

Yasushi ISHIOKA	Master	Leg-1 + 2
Takeshi ISOHI	Chief Officer	Leg-1 + 2
Norichika WATANABE	First Officer	Leg-1 + 2
Yoshiharu TSUTSUMI	Jr. First Officer	Leg-1
Takao NAKAYAMA	3rd First Officer	Leg-1
	Jr. First Officer	Leg-2
Nobuo FUKAURA	Second Officer	Leg-1 + 2
Hiroki KOBAYASHI	Third Officer	Leg-1 + 2
Hiroyuki SUZUKI	Chief Engineer	Leg-1 + 2
Yoichi FURUKAWA	First Engineer	Leg-1 + 2
Koji MANAKO	Second Engineer	Leg-1 + 2
Yusuke KIMOTO	Third Engineer	Leg-1 + 2
Wataru TOKUNAGA	Technical Officer	Leg-1 + 2
Yosuke KUWAHARA	Boatswain	Leg-1 + 2
Kazuyoshi KUDO	Able Seaman	Leg-1 + 2
Tsuyoshi SATOH	Able Seaman	Leg-1 + 2
Tsuyoshi MONZAWA	Able Seaman	Leg-1 + 2
Keita NISHIMURA	Ordinary Seaman	Leg-1 + 2
Hideaki TAMOTSU	Ordinary Seaman	Leg-1 + 2
Hideyuki OKUBO	Ordinary Seaman	Leg-1 + 2
Masaya TANIKAWA	Ordinary Seaman	Leg-1 + 2
Kazunari MITSUNAGA	Ordinary Seaman	Leg-1 + 2
Shohei UEHARA	Ordinary Seaman	Leg-1 + 2
Tetsuya SAKAMOTO	Ordinary Seaman	Leg-1 + 2
Sadanori HONDA	No.1 Oiler	Leg-1 + 2
Nobuo BOSHITA	Oiler	Leg-1 + 2
Kazumi YAMASHITA	Oiler	Leg-1 + 2
Hiromi IKUTA	Ordinary Oiler	Leg-1 + 2
Keisuke YOSHIDA	Ordinary Oiler	Leg-1
Shintaro ABE	Ordinary Oiler	Leg-2
Yuichiro TANI	Ordinary Oiler	Leg-1 + 2
Tamotsu UEMURA	Chief Steward	Leg-1 + 2
Ryotaro BABA	Cook	Leg-1 + 2
Masao HOSOYA	Cook	Leg-1 + 2
Michihiro MORI	Cook	Leg-1 + 2
Yoshiteru HIRAMATSU	Cook	Leg-1 + 2
Yoshiki TAKAHASHI	Cook	Leg-1 + 2

5.1 GPS Radiosonde

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio YONEYAMA*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki KATSUMATA***	(JAMSTEC)	- Principal Investigator (Leg-2)
Kazuaki YASUNAGA**	(JAMSTEC)	
Mariko SEKI**	(JAMSTEC)	
Keisuke TASHIRO**	(JAMSTEC)	
Ayumi KUROTAKI*	(JAMSTEC)	
Aya TSUBOI *	(Kyoto Univ.)	
Nao TAKAMURA*	(Kyoto Univ.)	
Junko SUZUKI***	(JAMSTEC)	
Ayako SEIKI **	(JAMSTEC)	
Momoko KIMURA**	(JAMSTEC)	
Tetsuya TAKEMI	(Kyoto Univ.)	- not on board
Taro SHINODA	(Nagoya Univ.)	- not on board
Souichiro SUEYOSHI***	(GODI)	- Operation Leader (Leg-1 and 2)
Asuka DOI***	(GODI)	
Toshimitsu GOTO***	(GODI)	
Katsuaki MAENO *	(GODI)	
Ryo KIMURA*	(GODI)	
Satoshi OKUMURA**	(GODI)	
Kazuho YOSHIDA**	(GODI)	
Wataru TOKUNAGA***	(MIRAI Crew)	

(2) Objectives

To obtain atmospheric profile of temperature, humidity, and wind speed/direction, and their temporal variations

(3) Methods

(3-1) Vaisala system

Atmospheric sounding by radiosonde by using system by Vaisala Oyj was carried out. The GPS radiosonde sensor (RS92-SGPD) was launched with the balloons (Totex TA-200/350). The on-board system to calibrate, to launch, to log the data and to process the data, consists of processor (Vaisala, SPS-311), processing and recording software (DigiCORA III, ver.3.64), GPS antenna (GA20), UHF antenna (RB21), ground check kit (GC25), and balloon launcher (ASAP). In the ”ground-check” process, the pressure sensor (Vaisala PTB-330) was also utilized as the standard. In case the relative wind to the ship (launcher) is not appropriate for the launch, the handy launch was selected.

The radiosondes were launched every 3 hours from 00UTC on Sep.28, 2011 to 00UTC on Oct.26, 2011 for leg-1, and from 03UTC, Oct. 29, 2011 to 00UTC, Dec.01, 2011 for leg-2. Both periods include the stationary observation period at (8S, 80.5E) and transfer period before and after the stationary observation. In addition, 6-hourly observation was also performed from 06UTC on Sep.26, 2011 to 00UTC on Sep.28, 2011. In total, 500 soundings were carried out, as listed in Table 5.1-1.

(3-2) Meisei system

The radiosonde system by using Meisei Inc. was also utilized. The system used in the observations consists of GPS sounding receiver system (Meisei RS-08AC), and an laptop PC with the processing software “MGPS_R”. The sensor (RS-06G) was attached to the balloon (Totex TA-200) then launched. All launches were made by handy one, i.e. by not using the automatic launcher

The all launches are listed as Table 5.1-2. M001 and M002 were launched with tethering to Vaisala RS92. M003 and M004 were launched singly (using one RS-06G sensor to one TA-200 balloon) as test flights for water vapor sonde (see Section 5.8). M005 to M009 were launched singly but near-simultaneously to the Vaisala RS92 launch for intercomparison. M010 to M020 were launched in the middle of the launch time of Vaisala RS92 to enable high temporal resolution (every 1.5 hours from 0530UTC on Nov.28, 2011 (M010) to 1430UTC on Nov.29, 2011, by combining observations by Vaisala RS92 and Meisei RS06G).

(4) Preliminary Results

The results from Vaisala system are shown in the figures, while data from Meisei system will be examined. Figure 5.1-1 is the time-height cross sections during the stationary observation period at (5N, 139.5E) for equivalent potential temperature, relative humidity, zonal and meridional wind components. Several basic parameters are derived from sounding data as in Fig. 5.1-2, including convective available potential energy (CAPE), convective inhibition (CIN) and total precipitable water vapor (TPW). Each vertical profiles of temperature and dew point temperature on the thermodynamic chart with wind profiles are attached in Appendix-A.

(5) Data archive

Data were sent to the world meteorological community via Global Telecommunication System (GTS) through the Japan Meteorological Agency, immediately after each observation. Raw data is recorded as ASCII format every 2 seconds (Vaisala) or every 1 second (Meisei) during ascent. These raw datasets will be submitted to JAMSTEC Data Integration and Analyses Group. The corrected datasets will be available from Mirai website at http://www.jamstec.go.jp/cruisedata/mirai/e/, and CINDY website.

(6) Acknowldgement

Thanks are due to Dr. Kenji SUZUKI of Yamaguchi Univ. to provide the instruments for Meisei radiosonde observation system.

Table 5.1-1: Radiosonde launch log, with surface values and maximum height for Vaisala RS92-SGPD.

ID	Date	Launched Location		Surface States					Max. height	Cloud at Launch	
		Latitude	Longitude	P	T	RH	WD	WS		Am.	Type
		degN	degE	hPa	degC	%	deg	m/s	m		
Leg-1											
RS001	2011092606	1.817	88.506	1009.9	28.3	74	258	7.6	24168	9	Cu,Ci,As
RS002	2011092612	1.026	87.617	1007.8	28.3	75	244	4.1	23194	4	Cu,Ci
RS003	2011092618	0.348	86.565	1010.2	28.2	77	247	6.7	23216	9	unknown
RS004	2011092700	−0.322	85.632	1007.8	28.2	78	239	7.7	24352	8	Cb,Ac
RS005	2011092706	−1.016	84.672	1009.7	27.9	78	243	6.4	23012	3	Cu,Ci,Ac
RS006	2011092712	−1.678	83.765	1006.8	28.2	77	235	4.3	21938	4	Cu,Ci
RS007	2011092718	−2.266	82.924	1009.7	27.8	75	238	2.5	21773	2	unknown
RS008	2011092800	−2.950	81.988	1007.4	27.3	81	218	2.6	24353	2	Cu,Ci
RS009	2011092803	−3.300	81.491	1010.1	28.8	74	245	3.0	22905	4	Cu,Ci
RS010	2011092806	−3.665	80.994	1010.0	28.0	74	283	0.6	22836	7	Cu,Cb,Ci
RS011	2011092809	−3.986	80.502	1007.6	27.4	78	292	6.0	24964	8	Cu,Ci
RS012	2011092812	−4.149	80.195	1007.1	27.4	80	314	7.0	24555	3	Cu,Ci
RS013	2011092815	−4.396	79.688	1008.5	27.3	75	302	3.6	23529	1	Cu

RS014	2011092818	−4.651	79.167	1010.3	27.5	80	334	1.4	23900	2	Cu
RS015	2011092821	−4.899	78.638	1007.6	27.3	76	335	1.8	23758	2	Cu
RS016	2011092900	−5.033	78.096	1007.2	27.4	75	350	1.3	22386	1	Cu,Cb,Ci
RS017	2011092903	−5.128	78.374	1009.5	27.5	78	92	1.4	18643	5	Cu,Ac
RS018	2011092906	−5.094	78.085	1009.9	24.9	88	203	1.3	20309	9	Cu,Cb
RS019	2011092909	−5.111	78.110	1006.9	27.7	77	337	0.7	23254	8	Cu,Ci,Ac
RS020	2011092912	−5.452	78.387	1007.0	28.1	72	77	2.2	22633	5	Cu,Cb
RS021	2011092915	−5.946	78.797	1009.4	27.3	79	4	0.8	22441	3	Cu
RS022	2011092918	−6.564	79.309	1010.1	28.0	78	37	6.0	20676	1	Cu
RS023	2011092921	−6.912	79.608	1008.1	27.1	82	41	1.2	23090	1	Cu
RS024	2011093000	−7.375	79.976	1008.0	27.2	83	79	3.5	23111	4	Cu,Cb,Ci,Ac
RS025	2011093003	−7.819	80.353	1010.0	26.5	85	118	5.4	23973	9	Cu,Cb
RS026	2011093006	−7.985	80.526	1010.7	25.7	84	80	4.5	24097	10	Cu,Cb
RS027	2011093009	−7.988	80.529	1008.0	26.5	76	80	3.9	23358	9	Cb,Cu
RS028	2011093012	−7.999	80.517	1007.3	26.5	79	97	6.0	21262	8	Cu,Cb,Ac
RS029	2011093015	−8.010	80.509	1009.8	26.0	82	103	7.8	19628	9	Cu,Ns
RS030	2011093018	−8.007	80.510	1010.5	24.8	91	135	6.3	22676	10	Ns
RS031	2011093021	−8.006	80.518	1008.8	24.8	90	95	1.9	23190	10	Ns
RS032	2011100100	−8.007	80.509	1007.9	25.9	81	89	6.8	22875	5	Cu,Cb,Ai
RS033	2011100103	−8.006	80.517	1010.1	25.8	85	105	7.0	23706	9	Cu,Sc
RS034	2011100106	−8.004	80.517	1010.3	25.5	90	135	6.0	22781	10	Cb
RS035	2011100109	−7.988	80.510	1008.1	24.6	94	118	12.0	23204	10	Cb
RS036	2011100112	−8.011	80.512	1007.7	24.6	95	133	10.3	−	−	−
RS037	2011100112	−7.999	80.487	1007.9	24.4	92	140	9.9	17714	10	Cb,Cu,Ns
RS038	2011100115	−7.995	80.504	1009.2	25.7	88	122	10.5	21554	10	Cb,Cu,Ns
RS039	2011100118	−8.014	80.488	1009.6	26.7	84	133	12.0	22042	10	Cb
RS040	2011100121	−8.087	80.501	1007.4	25.7	88	119	13.4	22536	10	Cb
RS041	2011100200	−8.008	80.503	1007.0	27.3	79	135	9.6	21677	9	Cu,Cb
RS042	2011100203	−8.002	80.507	1009.3	27.5	76	130	10.3	23319	9	Cu,Cb
RS043	2011100206	−8.010	80.520	1009.1	27.9	73	136	9.8	22853	9	Cu,Ci,Cs
RS044	2011100209	−8.010	80.513	1006.7	28.1	73	130	7.6	22397	6	Ci,Cu
RS045	2011100212	−8.019	80.508	1006.6	28.2	73	123	9.0	23625	4	Cu,Ci
RS046	2011100215	−8.010	80.510	1008.6	27.9	75	111	10.4	23178	1	Cu
RS047	2011100218	−8.004	80.518	1009.7	27.8	74	105	11.6	23269	3	Cu
RS048	2011100221	−8.002	80.511	1007.5	27.7	71	114	10.3	20302	2	Cu
RS049	2011100300	−8.010	80.504	1007.5	27.7	70	104	7.2	22212	5	Cu
RS050	2011100303	−8.009	80.515	1009.9	27.9	69	112	8.5	22877	9	Ci,Cu,Ac
RS051	2011100306	−8.012	80.524	1009.5	28.2	66	107	3.3	22854	8	Ci,Cu
RS052	2011100309	−8.013	80.514	1007.1	28.0	72	117	7.4	20860	6	Ci,Cu
RS053	2011100312	−8.010	80.512	1007.2	28.0	68	118	6.7	21528	5	Cu,Ci
RS054	2011100315	−8.001	80.503	1009.5	28.1	71	97	5.8	23087	1	Cu
RS055	2011100318	−8.001	80.508	1009.8	27.6	77	114	7.7	22673	5	Cu
RS056	2011100321	−8.004	80.526	1007.8	27.0	81	99	8.1	23288	2	Cu
RS057	2011100400	−8.005	80.515	1007.7	25.6	89	102	9.9	22812	10	Cu,Cb
RS058	2011100403	−8.016	80.513	1009.9	25.1	87	134	4.3	23996	9	As,Cu
RS059	2011100406	−8.023	80.517	1009.9	25.3	87	145	3.1	20930	10	Ns,Cu
RS060	2011100409	−8.016	80.512	1007.4	25.6	88	111	1.0	24128	10	Cb,Cu
RS061	2011100412	−8.010	80.510	1007.6	25.2	93	162	5.4	16435	10	Cb,Cu
RS062	2011100415	−7.990	80.502	1009.2	25.0	92	46	8.7	16500	10	Cb,Cu,Ns

RS063	2011100418	−8.002	80.495	1010.0	24.9	92	60	7.2	4390	10	Cu,Ns
RS064	2011100421	−7.989	80.504	1008.6	24.2	86	29	5.3	4406	10	Cu,Ns
RS065	2011100500	−8.000	80.501	1008.6	25.2	88	163	5.6	26159	10	Cu,Cb
RS066	2011100503	−8.008	80.501	1010.5	27.9	74	106	10.9	23703	10	Cu,Cb,As
RS067	2011100506	−8.003	80.518	1009.9	28.0	75	95	9.9	24080	8	Cu,Ci,Ns
RS068	2011100509	−8.003	80.517	1007.8	27.9	75	97	9.7	22915	9	Cu,Ci
RS069	2011100512	−7.998	80.505	1007.5	28.1	76	101	13.1	22718	9	Cb,Cu,Ci
RS070	2011100515	−8.001	80.494	1009.2	27.9	72	110	13.1	23628	4	Cu,Ci
RS071	2011100518	−8.004	80.496	1010.4	27.9	73	100	8.1	21574	5	Cu,Ci,Cb
RS072	2011100521	−8.002	80.513	1008.5	27.7	76	109	10.0	22274	3	Cu,Cb
RS073	2011100600	−8.005	80.508	1008.5	27.7	74	108	11.3	22053	2	Cu,Ci
RS074	2011100603	−8.010	80.503	1010.9	27.9	74	103	10.0	23479	3	Cu,Ci
RS075	2011100606	−8.011	80.511	1011.3	28.0	75	116	8.1	24455	7	Ci,Cu
RS076	2011100609	−8.024	80.501	1009.2	28.2	70	110	7.4	22628	6	Ci,Cu
RS077	2011100612	−8.011	80.515	1009.4	28.2	70	127	7.4	23092	5	Cu,Ci,Cc
RS078	2011100615	−7.998	80.495	1011.4	27.9	75	102	6.8	23090	3	Cu,Ci
RS079	2011100618	−8.008	80.501	1011.9	27.3	77	123	6.0	23661	7	Cu
RS080	2011100621	−8.010	80.512	1009.6	26.9	83	132	8.1	23161	6	Cu,Ns
RS081	2011100700	−8.010	80.507	1009.8	26.8	78	132	9.8	22171	3	Ac,Ci
RS082	2011100703	−8.015	80.510	1011.7	27.5	76	139	10.1	23258	8	Cu,Ac,Cb
RS083	2011100706	−8.018	80.494	1011.2	27.9	72	133	9.3	19000	5	Cu,Ci
RS084	2011100709	−8.022	80.513	1009.1	27.9	73	146	7.6	23167	6	Cu,Ci
RS085	2011100712	−8.015	80.507	1009.5	28.0	75	142	6.1	23926	3	Cu
RS086	2011100715	−7.993	80.496	1011.2	27.8	73	139	5.8	22271	2	Cu
RS087	2011100718	−8.006	80.506	1011.3	27.4	74	111	3.9	22716	4	Cu,Cb
RS088	2011100721	−7.999	80.517	1009.1	25.3	88	102	7.5	21866	9	Cu,Cb,Ns
RS089	2011100800	−7.998	80.512	1009.6	24.9	86	119	5.9	23160	10	Cu,Cb
RS090	2011100803	−8.007	80.515	1011.4	24.9	85	97	2.5	24445	10	As,Cu
RS091	2011100806	−7.997	80.509	1010.9	25.6	87	88	5.8	23605	10	As,Ns,Cu,Ci
RS092	2011100809	−7.998	80.518	1008.4	26.6	79	119	7.2	23357	9	Cb,Cu,As
RS093	2011100812	−7.998	80.488	1009.0	24.6	85	125	9.9	23331	10	As,Cu
RS094	2011100815	−8.104	80.510	1010.2	27.5	76	148	4.1	22060	10	As,Cu
RS095	2011100818	−8.000	80.499	1010.6	27.8	74	125	7.0	23715	10	As,Ns,Cu
RS096	2011100821	−8.002	80.511	1008.4	27.3	77	127	10.5	23447	6	Cu,Sc
RS097	2011100900	−8.001	80.506	1008.4	26.4	74	127	11.7	23627	8	Cu,Ns
RS098	2011100903	−8.009	80.505	1010.7	25.6	88	111	8.7	23966	10	Cu,As,Ns
RS099	2011100906	−8.002	80.506	1010.2	27.6	78	105	8.4	24316	9	Cb,Ci
RS100	2011100909	−8.009	80.508	1008.3	25.9	86	81	5.3	24275	10	Cb.Cu,Ns
RS101	2011100912	−7.999	80.514	1008.1	26.9	81	86	5.7	21973	9.5	Cu, Sc, As
RS102	2011100915	−7.994	80.493	1009.9	26.7	83	115	5.3	20898	4	Cu, Sc, As
RS103	2011100918	−8.015	80.498	1010.5	26.4	90	138	7.4	23381	9	Cu,Cb,Ns,Sc
RS104	2011100921	−8.008	80.517	1008.5	25.7	88	116	8.5	21754	10	Cu,As
RS105	2011101000	−8.006	80.507	1008.2	26.0	86	127	9.7	23418	7	Cu,Ci
RS106	2011101003	−8.008	80.507	1011.3	24.7	94	149	13.9	23327	10	As,Cb,Cu
RS107	2011101006	−8.012	80.505	1011.2	25.9	83	137	9.2	23160	10	As,Cb,Cu
RS108	2011101009	−8.011	80.512	1009.2	26.5	80	98	10.7	23799	10	As,Cb,Cu
RS109	2011101012	−7.994	80.514	1008.0	25.8	86	126	9.1	17053	10	As,Cb,Cu
RS110	2011101015	−7.994	80.496	1009.8	26.6	84	117	12.6	23016	10	As,Cb,Cu
RS111	2011101018	−8.014	80.496	1010.7	27.1	77	118	13.2	22157	10	As,Cb

RS112	2011101021	−8.020	80.499	1008.3	26.0	83	131	12.6	23758	9.5	Cu,Cb,Sc,As
RS113	2011101100	−8.015	80.508	1008.4	27.1	69	136	12.7	23156	7	As,Cu,Ci
RS114	2011101103	−8.013	80.507	1010.7	27.2	72	128	12.4	24040	9	Cu,Ac
RS115	2011101106	−8.011	80.513	1011.2	27.6	62	130	9.9	25294	8	As,Ac
RS116	2011101109	−8.015	80.516	1008.0	27.4	67	119	10.5	23601	8	As,Ci
RS117	2011101112	−8.012	80.503	1008.6	27.5	71	105	12.4	22749	10	Cu,As
RS118	2011101115	−7.998	80.497	1010.0	27.6	66	120	7.3	20459	10−	Cu,As
RS119	2011101118	−7.995	80.497	1011.2	27.4	72	126	9.0	22889	9	As,Ac,Cu
RS120	2011101121	−8.003	80.513	1008.8	27.4	73	118	9.2	21424	9	As,Ac,Cu
RS121	2011101200	−8.007	80.507	1009.0	27.3	71	94	6.5	23080	6	As,Ac,Cu
RS122	2011101203	−8.008	80.507	1010.3	27.5	69	106	10.7	24092	2	Cu,Ci
RS123	2011101206	−8.003	80.504	1010.4	27.6	72	109	8.9	23281	6	Cu,Ci,Cb
RS124	2011101209	−8.004	80.505	1008.0	27.6	71	110	8.7	24733	6	Cu,Ci
RS125	2011101212	−8.007	80.512	1007.4	27.7	73	107	6.5	23459	7	Cu,Ci
RS126	2011101215	−7.989	80.500	1009.2	27.7	71	111	9.5	21243	6	Cu,Ci
RS127	2011101218	−8.023	80.492	1010.3	27.6	69	106	6.8	23034	5	Cu,Ci
RS128	2011101221	−8.011	80.514	1007.7	27.3	71	111	7.3	22666	5	Ci,Cu
RS129	2011101300	−8.006	80.512	1007.4	27.2	70	103	7.8	22524	3	Cu,Ci
RS130	2011101303	−8.006	80.513	1010.1	27.4	70	111	9.8	23372	9	Ac,Cu
RS131	2011101306	−8.007	80.507	1009.7	27.7	67	111	9.8	24796	4	Cu,Ci
RS132	2011101309	−8.000	80.504	1006.8	27.8	70	102	8.8	23239	3	Cu,Cb,Ac
RS133	2011101312	−8.001	80.499	1006.7	27.6	72	117	9.3	21854	6	Ci,Cu
RS134	2011101315	−7.997	80.483	1008.1	27.7	71	93	6.8	20658	6	Ci,Cu
RS135	2011101318	−8.014	80.506	1009.1	27.6	69	105	9.5	21528	5	Ci,Cu
RS136	2011101321	−8.006	80.514	1007.3	27.4	70	107	7.0	23707	2	Cu,Ci
RS137	2011101400	−8.005	80.510	1007.4	27.2	71	103	5.5	23451	2	Cu,Ci
RS138	2011101403	−8.001	80.506	1009.2	27.7	73	101	8.9	22847	1−	Cu
RS139	2011101406	−8.003	80.500	1009.1	27.8	70	100	8.0	24017	6	Cu,Ci,Ac
RS140	2011101409	−8.005	80.511	1006.8	27.9	69	106	8.0	23921	3	Cu,Sc
RS141	2011101412	−8.005	80.508	1006.4	27.8	75	99	6.3	22028	5	Ac,Cu,Sc
RS142	2011101415	−8.006	80.511	1008.2	27.7	77	86	8.7	21453	4	Cu,Ci
RS143	2011101418	−8.002	80.510	1008.4	27.6	79	121	10.4	22544	3	Sc,Ci
RS144	2011101421	−8.009	80.513	1006.3	27.6	77	110	9.6	22033	3	Ci,Sc
RS145	2011101500	−7.998	80.505	1006.4	27.5	79	108	8.4	21273	5	Cu,Ci,As
RS146	2011101503	−8.004	80.508	1008.4	27.9	78	122	10.4	24217	8	Cu,As
RS147	2011101506	−8.003	80.505	1008.6	28.1	75	109	9.4	23671	7	Cu,Cb,As
RS148	2011100609	−8.007	80.507	1006.3	28.1	77	87	9.0	22038	9	Cu,Ci,Cb,Sc
RS149	2011101512	−8.001	80.511	1006.6	28.0	77	84	8.9	22633	5	Cu,Ac.Ci
RS150	2011101515	−7.991	80.502	1008.8	28.2	79	88	6.2	22913	2	Ci
RS151	2011101518	−8.020	80.505	1009.2	27.9	76	100	8.0	22743	2	Cu
RS152	2011101521	−8.001	80.519	1007.1	27.7	77	84	5.6	20597	4	Ci,Cu
RS153	2011101600	−8.000	80.513	1006.6	27.5	77	101	6.2	22775	2	Cu,As
RS154	2011101603	−8.004	80.513	1008.7	28.0	78	105	9.7	23669	2	Cu,Ci
RS155	2011101606	−8.005	80.507	1007.9	28.0	74	114	9.0	21889	6	Cu,Ci,As
RS156	2011101609	−8.009	80.508	1005.5	28.2	71	99	11.8	23811	5	Cu,Ci,Cb
RS157	2011101612	−8.002	80.512	1005.6	28.1	75	99	9.9	22626	8	Cs,Ci,Cu
RS158	2011101615	−7.992	80.502	1007.7	27.9	75	97	6.7	21132	0	−
RS159	2011101618	−8.017	80.503	1008.7	28.0	74	88	8.2	22899	3	Ci,Cu
RS160	2011101621	−8.007	80.513	1007.4	27.8	76	108	7.7	20480		Cu,Ci

RS161	2011101700	−8.013	80.508	1007.5	27.5	74	119	9.6	23176	2	Cu,Ci
RS162	2011101703	−8.018	80.502	1009.4	27.9	73	123	9.1	23393	3	Cu,Ci
RS163	2011101706	−8.011	80.505	1009.3	28.1	71	112	10.0	21743	9	Cu,Ci,Cs
RS164	2011101709	−8.017	80.504	1006.8	28.2	73	112	8.2	22399	9.5	Cu,Cb,Ci,Ns
RS165	2011101712	−8.010	80.510	1006.3	28.0	76	107	9.7	20647	7	Cu,Ci
RS166	2011101715	−8.002	80.502	1008.8	27.9	75	104	7.4	22374	3	Cu,Ci
RS167	2011101718	−8.008	80.516	1009.4	27.8	72	100	11.1	21146	1	Cu,Ci
RS168	2011101721	−8.002	80.520	1007.4	27.5	73	107	6.3	21988	2	Ci,Cu
RS169	2011101800	−8.006	80.509	1006.8	27.3	76	123	8.3	23912	2	Ci,Cu
RS170	2011101803	−8.005	80.503	1008.6	27.7	78	125	10.5	23415	4	Cu,Ci,Sc
RS171	2011101806	−8.016	80.498	1008.2	28.0	75	109	10.8	22406	6	Cu,Ci
RS172	2011101809	−8.006	80.508	1006.3	28.1	71	105	9.3	23007	7	Cu,Cb,Ci
RS173	2011101812	−8.002	80.509	1006.1	28.1	74	120	10.3	23303	5	Cu,Ci
RS174	2011101815	−7.994	80.500	1007.4	27.8	75	105	6.3	22273	1	Cu,Ci
RS175	2011101818	−8.008	80.508	1008.7	27.9	70	108	8.9	22099	0	−
RS176	2011101821	−8.009	80.513	1006.8	27.5	73	99	5.8	22487	0	−
RS177	2011101900	−8.008	80.510	1006.8	27.3	74	96	6.2	24438	3	Cu,Ci,Ac
RS178	2011101903	−8.005	80.509	1008.3	27.6	70	97	9.0	23643	4	Cu,Ci
RS179	2011101906	−8.004	80.502	1008.0	27.9	71	109	7.9	22078	5	Cu,Ci
RS180	2011101909	−8.007	80.511	1005.6	27.8	71	105	6.8	22688	8	Cu,Ci,Sc
RS181	2011101912	−8.006	80.509	1005.7	27.7	71	98	6.7	22244	6	Cu,Ci,As
RS182	2011101915	−7.989	80.505	1007.5	27.7	67	89	6.7	20524	1	Cu,
RS183	2011101918	−8.015	80.511	1008.1	27.6	73	72	5.2	22550	0	−
RS184	2011101921	−7.995	80.524	1006.5	27.4	74	101	6.5	22780	1	Cu,Ci
RS185	2011102000	−8.004	80.509	1006.6	27.2	74	85	4.3	23400	2	Cu,Ci
RS186	2011102003	−8.006	80.511	1008.2	27.8	69	98	5.0	23885	3	Cu,Ci
RS187	2011102006	−8.001	80.542	1007.4	27.9	73	105	4.7	23896	3	Cu,Ci
RS188	2011102009	−7.994	80.530	1005.2	28.0	74	114	5.0	23734	4	Cu
RS189	2011102012	−7.993	80.527	1005.3	28.1	76	118	6.8	22983	1	Cu
RS190	2011102015	−7.993	80.527	1008.0	28.0	76	104	4.9	22901	1	Cu
RS191	2011102018	−7.988	80.517	1008.2	27.7	79	118	5.4	22504	0	−
RS192	2011102021	−7.989	80.519	1006.6	27.5	74	111	6.1	22863	0	−
RS193	2011102100	−7.995	80.524	1006.7	27.4	77	107	5.5	23181	0	−
RS194	2011102103	−7.986	80.521	1008.5	27.7	75	98	6.3	23808	1	Cu,Ci
RS195	2011102106	−7.992	80.515	1007.4	27.9	75	100	6.3	23519	2	Cu
RS196	2011102109	−8.001	80.510	1005.0	28.2	74	101	5.2	22854	1	Cu,Cb,Ci
RS197	2011102112	−7.999	80.510	1004.8	28.1	74	90	3.8	23704	2	Cu
RS198	2011102115	−7.988	80.506	1007.3	27.8	74	87	4.7	22262	1	Cu
RS199	2011102118	−8.012	80.491	1007.3	27.8	77	84	5.3	22147	0	−
RS200	2011102121	−8.007	80.518	1005.0	27.3	78	84	4.3	22686	0	−
RS201	2011102200	−8.001	80.499	1005.2	27.1	78	103	4.7	22920	1	Cu,Ci
RS202	2011102203	−8.001	80.505	1007.2	27.7	70	92	3.5	23947	1	Ci,Cu
RS203	2011102206	−8.001	80.503	1006.8	27.9	72	91	4.0	22971	4	Cu,Cb,Ci
RS204	2011102209	−8.000	80.508	1004.6	28.3	70	90	3.5	23516	5	Cu,Ci
RS205	2011102212	−8.006	80.516	1004.5	28.3	69	93	2.2	22543	2	Cu,Ci
RS206	2011102215	−7.987	80.500	1006.7	27.7	73	106	3.0	23500	1	Cu
RS207	2011102218	−8.000	80.501	1007.1	28.0	72	80	3.1	23460	0	−
RS208	2011102221	−8.003	80.518	1004.9	27.4	74	90	4.1	22999	0	−
RS209	2011102300	−8.001	80.511	1005.0	27.1	74	62	4.6	23225	1	Cu,Ci

RS210	2011102303	-7.998	80.510	1006.9	28.1	70	85	5.5	24034	2	Cu,Ci
RS211	2011102306	-7.996	80.516	1006.6	28.4	71	78	7.2	23335	4	Cu,Ci,Sc
RS212	2011102309	-7.998	80.516	1004.7	27.9	70	85	5.5	23190	3	Cu,Cb,Sc
RS213	2011102312	-7.996	80.513	1004.6	28.0	67	76	4.0	23060	2	Ci,Cu
RS214	2011102315	-8.000	80.510	1006.6	27.6	72	76	5.7	21034	1	Cu
RS215	2011102318	-8.003	80.517	1007.4	27.6	70	65	4.8	21871	1	Cu
RS216	2011102321	-7.991	80.514	1005.9	27.4	74	68	7.8	19919	2	Cu
RS217	2011102400	-7.996	80.510	1005.9	27.3	71	58	6.4	23955	1	Cu,Ci
RS218	2011102403	-7.998	80.506	1007.6	27.8	74	65	5.3	23821	4	Cu,Ci
RS219	2011102406	-8.000	80.507	1007.1	27.8	72	67	5.9	23738	4	Cu,Ci
RS220	2011102409	-7.710	80.491	1004.7	27.7	68	84	5.0	21595	2	Cu,Ci
RS221	2011102412	-6.966	80.598	1004.9	27.9	71	107	4.0	21714	6	Cu,Ci
RS222	2011102415	-6.213	80.500	1007.0	27.9	73	101	4.4	20920	1	Cu
RS223	2011102418	-5.505	80.497	1007.6	27.9	75	108	5.3	22722	4	Cu,Ci
RS224	2011102421	-4.759	80.487	1005.4	27.9	75	98	3.1	20994	7	Cu,Ci
RS225	2011102500	-4.031	80.525	1005.7	27.4	79	0	1.4	22843	7	Cu,Ci,Sc
RS226	2011102503	-3.286	80.501	1007.0	27.4	79	265	4.8	23955	7	Cu,Ci,Ac
RS227	2011102506	-2.543	80.506	1006.3	28.4	73	198	2.8	23961	7	Cu,Ci,Ac
RS228	2011102509	-1.849	80.506	1003.3	28.5	72	212	3.9	21272	9.5	Cu,Ci,Ac,Sc
RS229	2011102512	-1.146	80.386	1003.4	28.0	72	174	2.4	23176	9	Cu,As
RS230	2011102515	-0.469	80.151	1005.3	28.7	74	184	4.8	23256	4	Cu,Ac(As)
RS231	2011102518	-0.003	80.001	1006.0	28.4	73	151	5.9	22952	2	Cu
RS232	2011102521	0.487	79.979	1003.9	28.2	73	146	5.4	21111	4	unknown
RS233	2011102600	1.216	79.939	1004.2	26.3	83	22	3.9	21055	6	Cu,Ci
Leg-2											
RS234	2011102903	1.696	79.909	1006.7	25.8	89	268	7.1	23089	10	Cu,Sc
RS235	2011102906	0.949	80.016	1005.9	27.2	80	260	7.4	24530	10	Cu,Sc,As
RS236	2011102909	0.382	80.053	1003.8	25.4	89	288	5.3	22628	10-	Cu,Cb,Sc,As
RS237	2011102912	-0.330	80.126	1004.7	23.7	94	248	5.9	4691	10-	Cu,Cb,Sc
RS238	2011102915	-0.996	80.199	1006.7	25.7	85	257	2.8	22013	10-	Cu,Sc
RS239	2011102918	-1.756	80.266	1007.6	24.1	93	232	12.5	19660	10-	Cb
RS240	2011102921	-2.458	80.330	1005.2	26.7	85	262	5.8	19816	-	unknown
RS241	2011103000	-3.177	80.407	1004.9	26.7	81	255	4.1	23567	9	Cu,Sc
RS242	2011103003	-3.845	80.476	1007.3	26.6	84	278	7.7	23415	8	Cu,Sc
RS243	2011103006	-4.441	80.487	1006.9	27.5	78	301	3.8	24081	7	Cu,Sc,Ac
RS244	2011103009	-5.122	80.486	1005.0	27.4	73	259	6.0	23380	7	Cu,As,Sc,Ci,CC,Cs,Cb
RS245	2011103012	-5.763	80.483	1005.3	25.3	85	332	3.2	19664	8	Cu,Cb,Cs,As,Cc
RS246	2011103015	-6.411	80.498	1006.6	27.6	74	180	2.0	23708	5	Cu,Sc
RS247	2011103018	-7.050	80.508	1007.3	27.5	78	147	3.1	21796	4	Sc,As
RS248	2011103021	-7.685	80.513	1005.4	27.2	78	132	6.0	18003	5	St,Sc,As
RS249	2011103100	-8.005	80.494	1005.5	27.2	75	99	6.4	22605	5	Cu,Ac,Sc
RS250	2011103103	-8.000	80.501	1007.7	27.5	76	117	6.4	22243	8	Cu,Sc,Ci
RS251	2011103106	-8.009	80.508	1007.8	27.8	77	113	6.8	23046	7	Cu,Sc
RS252	2011103109	-8.011	80.511	1006.2	27.6	75	122	5.1	24163	10	Cu,As,Cc,Ci,Cs
RS253	2011103112	-8.005	80.513	1006.3	27.9	74	120	5.5	23998	10	Cu,As
RS254	2011103115	-8.009	80.514	1008.3	27.7	71	115	6.4	20754	9	Cu,As
RS255	2011103118	-8.010	80.523	1008.6	27.5	76	108	3.9	22468	10	Cu,As
RS256	2011103121	-8.006	80.513	1007.1	27.2	78	113	5.1	23504	-	unknown
RS257	2011110100	-8.012	80.510	1007.2	27.2	80	112	6.3	23417	5	Cu,Sc,Cs

RS258	2011110103	-8.005	80.508	1009.4	27.7	72	106	5.6	24503	3	Cu,As
RS259	2011110106	-8.007	80.509	1009.0	27.8	74	119	5.5	23839	6	Sc,Cu,As
RS260	2011110109	-8.017	80.507	1006.6	28.2	71	120	5.3	22990	9	Cu,Ci,Cs
RS261	2011110112	-8.019	80.507	1006.1	27.7	74	144	5.3	21857	9	Cu,St,Cs
RS262	2011110115	-8.008	80.502	1007.9	27.6	76	139	6.2	21365	7	Cu,As,Sc
RS263	2011110118	-8.033	80.507	1007.9	27.5	78	147	6.7	20528	6	Cu,Cs,St
RS264	2011110121	-8.012	80.516	1006.0	27.3	74	128	7.8	20909	8	Cu,Sc
RS265	2011110200	-8.012	80.502	1006.7	27.2	75	128	5.1	23026	6	Cu,Ac
RS266	2011110203	-8.008	80.508	1008.1	27.5	77	134	7.4	20479	7	Cu,ScAc
RS267	2011110206	-8.003	80.519	1008.0	27.6	78	137	6.8	15272	4	Cu,Sc
RS268	2011110209	-8.002	80.509	1005.8	27.6	79	144	6.4	23209	4	Cu,As
RS269	2011110212	-8.014	80.509	1005.6	28.2	73	114	6.7	23497	7	Cu,Ac
RS270	2011110215	-8.012	80.510	1007.2	27.1	81	151	9.4	22567	7	Cu,Sc,Cc
RS271	2011110218	-8.004	80.525	1007.3	27.5	78	101	7.5	23325	7	Sc,Cu,As
RS272	2011110221	-8.009	80.510	1005.6	27.2	70	103	9.3	23848	3	unknown
RS273	2011110300	-7.998	80.512	1005.7	27.2	77	107	7.6	24031	3	Cu,Sc,Ac
RS274	2011110303	-8.009	80.502	1007.9	27.5	69	112	9.4	24338	3	Ac,Cu
RS275	2011110306	-8.000	80.525	1007.6	27.7	72	110	6.0	23972	3	Cu,Sc
RS276	2011110309	-7.997	80.518	1005.4	27.8	72	94	6.8	23106	7	Cu,Cs
RS277	2011110312	-7.991	80.517	1005.8	27.7	78	76	4.1	22890	6	Cu,Cs
RS278	2011110315	-7.994	80.507	1007.6	27.5	72	75	6.0	22856	7	Cu,Cs
RS279	2011110318	-8.007	80.523	1008.3	27.5	75	77	6.7	23146	6	Cu,Sc
RS280	2011110321	-7.994	80.515	1007.0	27.4	76	65	5.2	23006	6	Cu,Cs
RS281	2011110400	-8.003	80.512	1007.4	25.2	79	97	6.8	22748	8	Cu,Sc,Ns
RS282	2011110403	-8.005	80.513	1009.4	27.4	77	108	5.9	23991	2	Cu
RS283	2011110406	-7.992	80.515	1008.8	27.6	71	105	5.1	24083	1	Cu
RS284	2011110409	-8.003	80.503	1006.2	28.2	72	89	5.0	23152	2	Cu
RS285	2011110412	-7.993	80.519	1006.5	27.7	75	111	7.1	21688	2	Cu
RS286	2011110415	-8.012	80.504	1008.8	27.7	78	114	6.3	23482	4	Cu
RS287	2011110418	-8.008	80.526	1009.6	27.6	76	100	8.5	22496	5	Cu
RS288	2011110421	-8.009	80.516	1007.9	27.4	77	81	8.2	21846	2	Cu
RS289	2011110500	-7.997	80.509	1008.2	27.3	78	92	8.0	22584	2	Cu,Sc
RS290	2011110503	-8.006	80.507	1010.7	27.7	76	100	6.4	22696	4	Cu
RS291	2011110506	-8.001	80.512	1009.6	27.7	78	114	6.0	21718	3	Cu,Ci
RS292	2011110509	-7.991	80.521	1007.2	27.4	79	101	6.4	21230	4	Cu,Cs
RS293	2011110512	-7.995	80.499	1006.9	27.4	77	104	8.7	21153	3	Cu,Cs
RS294	2011110515	-8.003	80.508	1009.1	27.4	79	102	6.3	22986	5	Cu
RS295	2011110518	-7.998	80.529	1009.8	27.2	80	96	8.1	21048	4	Cu
RS296	2011110521	-7.990	80.513	1007.8	27.0	81	103	8.4	23461	3	Cu
RS297	2011110600	-7.996	80.508	1008.0	27.1	79	109	6.7	23833	3	Cu
RS298	2011110603	-7.992	80.506	1010.2	27.6	75	95	9.3	23729	3	Cu,Sc
RS299	2011110606	-7.996	80.521	1009.8	27.6	75	105	7.7	22081	3	Cu
RS300	2011110609	-7.991	80.511	1007.2	28.1	78	98	6.4	23433	5	Cu,Cs,Ci
RS301	2011110612	-7.992	80.512	1007.0	27.7	72	96	7.1	22847	2	Cu
RS302	2011110615	-7.994	80.508	1009.1	27.7	76	84	7.4	22853	3	Cu
RS303	2011110618	-7.995	80.521	1009.7	27.5	76	78	7.0	22887	2	Cu
RS304	2011110621	-7.984	80.506	1007.2	27.2	80	70	8.2	22364	2	Cu
RS305	2011110700	-7.993	80.503	1008.0	27.3	79	74	8.0	23294	3	Cu,As
RS306	2011110703	-7.989	80.506	1010.0	27.3	83	86	9.5	23813	6	Cu,Ac

RS307	2011110706	-8.010	80.515	1010.3	27.4	81	101	8.0	25209	7	Cu,Sc,Ac
RS308	2011110709	-8.000	80.510	1008.7	25.9	77	116	8.6	24345	8	Cu,Ci,Sc
RS309	2011110712	-8.001	80.514	1007.9	26.6	82	104	8.0	21667	8	Cu, St, As, Ac, Ci
RS310	2011110715	-7.998	80.506	1009.6	26.7	83	83	8.5	22862	8	Cu,Sc,Ac,As
RS311	2011110718	-7.992	80.516	1010.2	27.4	79	93	10.4	22698	4	Cu
RS312	2011110721	-8.001	80.519	1008.2	26.9	81	83	8.8	21719	5	Cu
RS313	2011110800	-7.996	80.508	1008.4	27.2	83	86	7.6	24250	3	Cu
RS314	2011110803	-7.994	80.507	1009.9	27.3	77	89	9.6	23262	2	Cu,Ac
RS315	2011110806	-7.991	80.512	1010.1	27.7	77	101	9.3	23845	4	Cu,Ac
RS316	2011110809	-7.995	80.507	1007.9	27.7	74	91	7.7	23244	3	Cu,Ac,Sc
RS317	2011110812	-7.885	80.511	1008.0	27.8	77	103	9.1	7695	2	Cu,As
RS318	2011110815	-7.994	80.509	1010.5	27.6	75	92	9.1	21879	3	Cu,As
RS319	2011110818	-7.998	80.524	1010.6	27.6	77	95	10.3	23178	3	Cu,As,Ac
RS320	2011110821	-7.996	80.516	1007.8	27.2	74	101	10.5	21527	2	Cu,As
RS321	2011110900	-8.005	80.505	1007.9	27.0	77	109	9.9	23077	4	Cu
RS322	2011110903	-7.995	80.508	1010.1	27.5	71	95	9.5	23752	3	Cu,Ci
RS323	2011110906	-8.011	80.518	1009.9	27.5	69	96	6.7	23271	2	Cu,Ci,Ac
RS324	2011110909	-7.999	80.514	1008.0	27.6	66	115	7.1	20974	4	Cu,Ci,As,Sc
RS325	2011110912	-8.000	80.511	1007.6	27.3	70	129	8.7	20933	7	Ci,As,Cu
RS326	2011110915	-8.011	80.499	1010.1	27.2	72	141	5.3	23949	5	Cu,As,St
RS327	2011110918	-8.022	80.512	1011.3	27.2	74	143	6.1	21514	3	Cu
RS328	2011110921	-8.015	80.490	1008.2	26.9	71	132	8.2	22636	2	Cu,St
RS329	2011111000	-8.011	80.501	1007.5	26.8	71	128	9.8	23127	3	Cu,Ci
RS330	2011111003	-8.010	80.498	1009.2	27.2	73	122	8.2	20799	4	Cu,Ci
RS331	2011111006	-8.020	80.502	1008.5	27.3	73	130	9.6	23143	4	Cu,Ci
RS332	2011111009	-8.011	80.504	1006.1	27.4	69	135	9.2	23395	3	Cu,Ci,Sc
RS333	2011111012	-8.009	80.504	1006.1	27.4	72	136	7.8	21217	4	Cu
RS334	2011111015	-8.004	80.504	1008.7	26.7	74	132	3.3	20838	5	Cu,Sc
RS335	2011111018	-8.009	80.526	1009.8	27.1	72	118	6.9	23234	6	Cu,As,Ac
RS336	2011111021	-8.012	80.513	1007.5	26.8	73	88	5.9	22196	2	Cu
RS337	2011111100	-7.996	80.506	1007.3	26.6	77	91	6.3	22662	2	Cu
RS338	2011111103	-7.990	80.509	1009.2	27.4	76	89	8.3	22928	3	Cu,Ci
RS339	2011111106	-7.988	80.518	1009.1	27.4	73	83	6.0	23764	4	Cu,Ci
RS340	2011111109	-7.999	80.499	1007.1	25.7	83	103	4.7	23928	9	Cu,Ci,As
RS341	2011111112	-7.993	80.514	1006.7	27.7	69	102	6.8	20787	9	Cu, As, Cs
RS342	2011111115	-7.992	80.512	1009.2	27.3	76	99	6.0	23943	8	Cu,Cs,Sc
RS343	2011111118	-7.995	80.520	1009.9	27.0	79	69	5.3	22369	6	Cu,As,Ac
RS344	2011111121	-7.996	80.517	1007.7	27.0	76	80	5.6	22593	3	Cu,Sc
RS345	2011111200	-7.995	80.506	1007.7	26.7	77	87	4.9	23454	2	Cu,Ci,Sc
RS346	2011111203	-7.993	80.510	1009.5	27.3	75	137	3.8	23558	2	Cu,Ci,Sc,Ac
RS347	2011111206	-8.015	80.513	1009.2	27.2	77	152	1.6	23818	4	Cu,Ac,Ci
RS348	2011111209	-8.014	80.490	1007.2	27.1	77	210	2.9	24108	7	Cu,As,Ac
RS349	2011111212	-8.021	80.506	1007.2	26.1	83	140	9.3	22727	8	Cb,Cu,As
RS350	2011111215	-8.013	80.488	1009.1	26.4	83	179	4.9	19781	8	Cu,As,Ac
RS351	2011111218	-8.022	80.509	1009.4	26.2	82	114	1.3	22167	10	Cu, As, Sc
RS352	2011111221	-7.998	80.500	1006.5	26.1	84	16	0.3	22926	10	As,Ac,St
RS353	2011111300	-7.990	80.499	1006.8	26.4	84	3	3.1	22216	3	Cu,Sc
RS354	2011111303	-7.986	80.500	1009.5	26.9	82	30	1.3	23528	9	As,Cu
RS355	2011111306	-7.996	80.498	1008.9	27.3	81	68	5.0	23378	7	Cu,Ci

RS356	2011111309	-7.983	80.502	1006.4	27.3	81	52	4.6	22508	6	Cu,Ci,Ac,Sc
RS357	2011111312	-7.981	80.503	1006.1	27.3	77	63	5.6	22991	7	Cu,Cb,Si,Ci
RS358	2011111315	-7.998	80.500	1008.4	27.4	79	80	7.1	17216	4	Cu,St,As
RS359	2011111318	-7.988	80.518	1008.6	27.4	78	75	6.9	23333	6	Cu,Ci,Ac
RS360	2011111321	-7.987	80.511	1006.4	26.8	84	79	8.5	22645	7	Cu,Cb
RS361	2011111400	-7.989	80.505	1006.2	27.2	79	70	9.1	21012	1	Cu,St
RS362	2011111403	-7.986	80.498	1008.8	27.7	77	85	8.0	23622	4	Cu,Sc,As
RS363	2011111406	-7.982	80.523	1008.6	27.4	81	89	9.8	24444	4	Cu,As,Ci,Cc,Cg
RS364	2011111409	-8.006	80.508	1006.9	26.7	81	100	9.4	23931	7	Cu,Sc,Ac
RS365	2011111412	-7.998	80.501	1006.8	26.4	84	111	7.2	22429	9	Cu,Sc,Cb,As,Ac,Cc,Ci,C
RS366	2011111415	-7.997	80.505	1009.2	27.3	77	96	8.4	22812	0	-
RS367	2011111418	-8.011	80.511	1009.8	27.2	79	107	7.0	23133	3	Cu
RS368	2011111421	-8.024	80.490	1007.6	27.2	77	113	6.8	22725	6	Cu,Ac
RS369	2011111500	-8.008	80.508	1007.6	27.0	79	126	7.4	23288	5	Cu,As,Cb
RS370	2011111503	-8.018	80.510	1009.2	27.3	76	119	8.0	23329	3	Cu,As,St
RS371	2011111506	-8.018	80.515	1009.2	27.4	78	125	7.9	21533	3	Cu,As,Sc
RS372	2011111509	-8.017	80.499	1007.3	27.4	76	124	7.3	23279	6	cu,Cb,As,Sc
RS373	2011111512	-8.012	80.507	1006.4	27.4	77	119	8.6	22318	2	Cu, St
RS374	2011111515	-8.007	80.501	1008.4	27.4	82	109	9.7	22266	2	Cu
RS375	2011111518	-8.018	80.518	1008.5	27.3	81	93	10.5	23295	4	Cu
RS376	2011111521	-8.009	80.511	1006.2	27.2	79	91	9.2	21939	2	Cu
RS377	2011111600	-7.997	80.515	1006.4	27.1	81	112	8.1	23421	4	Cu,Sc,As
RS378	2011111603	-7.999	80.510	1007.9	27.7	73	94	9.9	23454	3	Cu,As,Cs,Ci
RS379	2011111606	-7.988	80.512	1008.4	27.5	78	82	7.9	22786	5	Cu,Ci,St,As
RS380	2011111609	-7.994	80.509	1006.4	27.5	78	89	9.1	23693	4	Cu,Ci,As,Ac
RS381	2011111612	-8.000	80.501	1006.3	27.6	75	121	6.0	17769	8	Cs,Ci,Cu
RS382	2011111615	-7.996	80.509	1008.4	27.4	78	123	6.4	19972	4	Ac,Sc
RS383	2011111618	-8.012	80.521	1009.0	27.3	81	100	5.1	22542	3	Cu,Ci
RS384	2011111621	-8.005	80.510	1006.8	27.0	79	121	4.6	22388	3	Cu
RS385	2011111700	-8.015	80.509	1007.0	26.9	83	140	4.8	23428	9	Cu,As,Cs,Ci
RS386	2011111703	-8.015	80.507	1008.9	27.2	81	125	7.2	24588	6	Cu,Ci,Cc,Cs,As
RS387	2011111706	-8.010	80.528	1008.4	27.4	79	116	6.3	24105	8	Cu,Ci,Cs,Sc,As
RS388	2011111709	-8.017	80.505	1006.3	27.4	80	129	6.3	23802	9	Cu,Sc,Ci,Cs
RS389	2011111712	-8.014	80.506	1005.8	27.4	80	121	7.9	22121	7	Cu,Cb,Cs,Sc
RS390	2011111715	-8.008	80.501	1008.1	27.3	78	100	9.4	23555	2	unknown
RS391	2011111718	-8.001	80.527	1008.4	27.5	79	101	10.0	23103	2	Sc
RS392	2011111721	-7.993	80.509	1006.3	27.2	81	103	9.5	22441	3	Cu
RS393	2011111800	-8.000	80.514	1006.1	27.2	78	96	8.6	23604	4	Cu,Ci,Cs,Sc
RS394	2011111803	-8.006	80.501	1008.0	27.6	79	101	8.5	23126	3	Cu,Cs,Ci,As
RS395	2011111806	-8.002	80.507	1007.5	27.2	79	110	9.5	23516	4	Cu,Cs,Ci,As
RS396	2011111809	-8.007	80.498	1004.9	27.7	77	109	11.6	23204	8	Cu,As,Sc,Cs
RS397	2011111812	-8.008	80.500	1005.0	26.0	83	95	9.7	23251	6	Cu,As
RS398	2011111815	-8.002	80.495	1007.3	27.6	80	103	10.0	21400	3	unknown
RS399	2011111818	-8.008	80.497	1007.8	26.5	80	98	11.6	23244	4	unknown
RS400	2011111821	-8.000	80.502	1005.9	26.9	86	104	8.7	21856	3	Cu
RS401	2011111900	-8.002	80.501	1006.1	26.6	83	90	9.7	23070	10	Cu,Cs,Ci,As,Sc
RS402	2011111903	-8.014	80.496	1008.1	27.7	77	97	12.3	24239	6	Cu,Ci,Cc,Cs,As
RS403	2011111906	-8.006	80.503	1008.0	27.6	80	86	6.6	23945	10	Cu,Cs,Ci,As
RS404	2011111909	-8.004	80.498	1005.4	27.4	82	68	7.9	21107	10	Cu,Sc,As,Cg,Cs

RS405	2011111912	−8.000	80.501	1005.2	27.0	81	71	9.0	18190	7	Cu,As
RS406	2011111915	−7.996	80.502	1007.8	27.1	79	81	7.1	20457	2	unknown
RS407	2011111918	−7.991	80.498	1008.6	27.0	81	105	5.3	21503	3	unknown
RS408	2011111921	−8.002	80.501	1006.5	26.8	78	109	10.0	22724	10	unknown
RS409	2011112000	−8.016	80.508	1006.5	27.2	77	108	8.9	22586	6	Cu,Ci,Cc,Cs,Sc
RS410	2011112003	−8.016	80.512	1008.3	27.5	73	105	8.8	23428	4	Cu,Ci,Cc,Cs
RS411	2011112006	−7.997	80.524	1008.7	27.6	77	97	7.5	24480	5	Cu,Cs,Ci
RS412	2011112009	−8.009	80.518	1006.9	28.2	72	112	6.5	23380	3	Cu,Ci
RS413	2011112012	−8.014	80.514	1006.7	27.5	74	120	6.6	22782	2	Cu,Ci
RS414	2011112015	−8.002	80.501	1008.8	27.5	72	110	9.1	22939	2	unknown
RS415	2011112018	−8.015	80.523	1009.2	27.2	74	110	7.4	21902	2	unknown
RS416	2011112021	−7.998	80.511	1006.6	26.8	74	112	6.8	22891	2	Cu
RS417	2011112100	−7.996	80.510	1007.0	26.7	75	112	8.3	21715	3	Cu,Ci
RS418	2011112103	−7.996	80.516	1008.3	26.9	72	98	6.4	23764	5	Cu,Cs,Ci
RS419	2011112106	−7.994	80.516	1007.4	27.1	73	88	5.5	22895	3	Cu,Cs,Ci
RS420	2011112109	−7.991	80.505	1005.1	27.2	72	109	6.7	23318	4	Cu,Cs,Ci
RS421	2011112112	−7.997	80.505	1004.7	27.4	74	108	5.9	22897	2	Cu,Ci
RS422	2011112115	−8.000	80.495	1007.4	27.3	75	103	4.9	21521	3	unknown
RS423	2011112118	−8.007	80.511	1007.9	27.1	78	98	4.3	21101	4	unknown
RS424	2011112121	−7.998	80.506	1005.8	26.8	79	83	3.9	21794	3	unknown
RS425	2011112200	−7.997	80.505	1005.9	26.6	77	95	5.0	21906	1	Cu,Ci,Cc,Cs
RS426	2011112203	−7.997	80.506	1007.5	27.0	75	95	3.4	23682	1−	Cu,Cs,Ci
RS427	2011112206	−8.002	80.524	1007.2	27.3	74	80	3.1	24104	1−	Cu,Ci
RS428	2011112209	−8.005	80.517	1004.6	27.3	76	90	3.3	24210	2	Cu,As,Ci
RS429	2011112212	−7.992	80.508	1004.4	27.4	75	131	3.1	22107	3	Cu,Ci
RS430	2011112215	−8.009	80.499	1006.8	27.5	76	110	3.7	22109	4	unknown
RS431	2011112218	−8.020	80.499	1007.2	27.2	76	101	5.0	22004	3	unknown
RS432	2011112221	−8.008	80.506	1004.9	26.8	77	125	3.6	23562	3	unknown
RS433	2011112300	−8.010	80.504	1004.8	26.5	78	127	4.8	21775	1	Cu,Ci
RS434	2011112303	−8.021	80.507	1006.7	27.2	75	125	5.4	22097	1	Cu,Ci,Cc
RS435	2011112306	−8.023	80.505	1006.4	27.3	77	120	5.5	23633	2	Cu,Ci
RS436	2011112309	−8.004	80.509	1004.1	27.4	78	103	5.4	23398	4	Cu,Ci,Cs
RS437	2011112312	−8.003	80.518	1003.4	27.3	80	139	6.1	23164	4	Cu,Ci
RS438	2011112315	−8.008	80.505	1005.4	27.3	79	121	6.0	23044	2	unknown
RS439	2011112318	−8.018	80.501	1005.8	27.0	80	137	6.0	21052	2	unknown
RS440	2011112321	−8.009	80.505	1003.6	26.6	83	143	6.5	22158	2	unknown
RS441	2011112400	−8.012	80.501	1003.5	26.7	83	135	7.7	22665	8	Cu,Ci,Sc,Ac,As
RS442	2011112403	−8.000	80.494	1005.6	27.3	82	140	9.4	24511	6	Cu,Ci,Cs
RS443	2011112406	−8.019	80.498	1005.6	27.0	81	155	8.5	23032	7	Cu,Ci,Cs,As
RS444	2011112409	−8.002	80.502	1003.4	27.5	76	146	6.9	23175	9	Cu,Sc,As,Cb
RS445	2011112412	−8.012	80.498	1003.3	27.5	77	165	8.6	21063	7	Cu,Cs,Ac,Sc
RS446	2011112415	−8.007	80.495	1005.9	27.5	73	149	8.6	20250	6	unknown
RS447	2011112418	−8.018	80.501	1006.1	25.6	86	129	9.4	20826	10	unknown
RS448	2011112421	−8.010	80.491	1003.6	24.6	92	181	8.2	21065	10	unknown
RS449	2011112500	−8.009	80.484	1003.5	25.8	88	186	6.3	23626	7	Cu,Ci,Cs,As
RS450	2011112503	−8.011	80.484	1005.6	26.8	80	161	6.8	23534	8	Cu,As,Ci,Cb,Ac,St
RS451	2011112506	−8.018	80.485	1005.3	26.6	83	159	4.9	19270	9	Cu,Ci,Sc,As
RS452	2011112509	−8.016	80.494	1003.0	26.3	86	127	7.1	24228	9	Sc,Cu,As,Ci,Cc
RS453	2011112512	−7.997	80.506	1003.2	26.5	84	94	8.6	22223	9	Cu,Cb,As

RS454	2011112515	-7.988	80.505	1005.5	26.4	79	58	4.2	20961	7	unknown
RS455	2011112518	-7.975	80.508	1006.8	26.7	79	45	1.7	20503	5	unknown
RS456	2011112521	-8.004	80.513	1004.4	26.8	82	120	1.4	17738	5	unknown
RS457	2011112600	-8.006	80.501	1004.3	25.0	87	9	5.0			
RS458	2011112600	-8.001	80.502	1004.8	25.4	84	59	8.9	22109	10-	Cu,Cb,As,Ci
RS459	2011112603	-7.992	80.512	1006.2	26.6	81	41	1.0	23706	9	Cu,Cb,Cs,Ci,As
RS460	2011112606	-8.000	80.525	1005.8	27.7	76	89	5.2	24006	8	Cu,Ci,Cs,Cc
RS461	2011112609	-8.008	80.501	1004.4	27.5	79	111	5.1	23934	8	Cu,Sc,As,Ci
RS462	2011112612	-8.003	80.509	1003.9	27.5	79	112	9.4	20425	6	Cu,As,Ci
RS463	2011112615	-7.998	80.509	1005.5	27.5	76	114	10.0	22384	3	unknown
RS464	2011112618	-7.990	80.518	1006.4	27.4	77	114	8.5	22322	4	unknown
RS465	2011112621	-7.998	80.508	1004.7	27.4	77	102	9.5	19552	4	unknown
RS466	2011112700	-8.003	80.503	1004.1	27.3	80	117	8.6	23162	4	Cu,Ci,Cs,Ac
RS467	2011112703	-8.013	80.505	1006.4	27.6	81	134	7.7	23983	6	Cu,Ci
RS468	2011112706	-8.023	80.509	1006.9	27.5	82	124	5.9	24677	10-	Cu,Cb,Ci,Cc,Ac,As
RS469	2011112709	-8.005	80.504	1004.7	27.9	82	117	6.9	24275	10	Cu,Sc,As,Cb,Cs
RS470	2011112712	-8.002	80.508	1004.7	24.7	90	165	2.9	21666	10	Cb, Cu, Sc, As
RS471	2011112715	-8.003	80.503	1005.9	27.4	84	125	8.6	22567	6	unknown
RS472	2011112718	-8.019	80.495	1006.2	27.2	84	117	8.9	20180	5	unknown
RS473	2011112721	-8.003	80.508	1004.1	26.8	86	124	8.5	21946	9	unknown
RS474	2011112800	-8.001	80.502	1003.5	27.4	83	123	8.1	20606	10	unknown
RS475	2011112803	-8.006	80.503	1005.8	26.8	86	127	5.3	23357	10-	Cb,Cu,Ci,Cs,Sc
RS476	2011112806	-8.002	80.514	1006.0	26.1	76	120	8.1	4865	10	Cu,Cb
RS477	2011112806	-8.000	80.497	1005.6	25.8	85	39	8.2	27245	10	Cu,Cb
RS478	2011112809	-7.882	80.341	1004.1	26.9	81	63	4.3	23853	10	Cu,Sc,As
RS479	2011112812	-7.361	79.950	1003.9	25.4	91	90	6.6	5003	10	Cu, Cb, As
RS480	2011112815	-6.777	79.461	1005.0	26.8	84	118	8.6	23954	8	unknown
RS481	2011112818	-6.194	78.986	1005.6	25.7	93	45	7.4	19004	10	unknown
RS482	2011112821	-5.703	78.585	1002.1	26.2	86	333	8.8	18855	10-	unknown
RS483	2011112900	-5.289	78.237	1003.1	26.6	80	290	9.1	23106	10	unknown
RS484	2011112903	-5.087	78.099	1005.6	25.8	83	305	7.7	24314	10-	Cb,Cu,As,Ci,Sc
RS485	2011112906	-5.118	78.099	1006.0	26.3	86	350	4.1	22896	10	Cb, Cu, Sc, As
RS486	2011112909	-5.098	78.104	1003.7	26.9	79	297	5.3	22288	9	Cu,Sc,As,Cs
RS487	2011112912	-5.089	78.099	1002.9	27.8	77	282	7.1	22460	9	Ci,Cu
RS488	2011112915	-5.078	78.095	1005.6	27.6	73	288	6.2	22227	6	Unknown
RS489	2011112918	-4.510	78.314	1006.7	27.6	80	327	4.9	22129	9	Unknown
RS490	2011112921	-3.847	78.557	1005.4	26.3	81	274	7.9	21560	9	Unknown
RS491	2011113000	-3.575	78.819	1005.3	27.8	77	291	7.1	22129	10	Unknown
RS492	2011113003	-2.477	79.074	1007.1	28.5	74	294	6.6	23128	9	Cu,As,Ci,Cs
RS493	2011113006	-1.782	79.334	1007.4	28.4	77	303	7.7	24074	5	Cu,Cs,Ci,Cc
RS494	2011113009	-1.069	79.606	1004.7	28.3	76	306	6.6	24744	10	Cu,CbCi,Cs
RS495	2011113012	-0.395	79.872	1005.1	28.0	79	320	4.5	21403	10	As
RS496	2011113015	0.004	80.017	1007.6	27.9	81	337	3.1	23369	10	As
RS497	2011113018	0.108	80.200	1007.7	27.9	80	280	4.6	-	-	-
RS498	2011113018	0.108	80.200	1007.7	27.8	81	272	3.5	21795	10	Unknown
RS499	2011113021	0.664	80.320	1006.4	27.8	78	304	3.4	21616	9	Unknown
RS500	2011120100	1.315	80.461	1005.7	27.5	77	16	0.7	21453	10	Unknown

Table 5.1-2: Radiosonde launch log, with surface values and maximum height, for Meisei RS-06G.

ID	Date and Time for Launch	Launched Location		Surface States					Max. height
		Latitude	Longitude	P	T	RH	WD	WS	
		degN	degE	hPa	degC	%	deg	m/s	m
M001	20110926 08:52	1.287	88.019	1007.2	28.3	73	238	3.7	N/A
M002	20110926 14:29	0.683	87.063	1010.0	28.4	75	237	4.8	23629
M003	20100930 06:57	−7.986	80.506	1009.3	26.2	77	102	4.8	23128
M004	20111031 09:48	−7.999	80.496	1011.0	27.9	76	115	4.4	23863
M005	20111119 05:37	−8.006	80.500	1013.1	28.2	75	88	7.9	21425
M006	20111120 17:32	−8.002	80.501	1009.2	27.7	74	106	7.5	23270
M007	20111125 05:55	−8.003	80.497	1005.0	27.0	82	155	4.9	(*1)
M008	20111126 20:27	−8.003	80.502	1005.8	27.7	77	107	9.0	24218
M009	20111127 17:29	−8.001	80.502	1006.2	27.4	84	121	10.1	21630
M010	20111128 07:02	−7.995	80.491	1005.3	26.7	85	5	5.2	23813
M011	20111128 10:00	−7.570	80.103	1003.6	26.5	82	75	4.8	22499
M012	20111128 12:57	−7.005	79.647	1004.4	25.6	87	94	7.1	17206
M013	20111128 15:59	−6.418	79.170	1005.5	26.5	88	93	4.3	16895
M014	20111128 19:00	−5.901	78.761	1003.6	27.1	83	345	9.4	17153
M015	20111128 21:58	−5.441	78.362	1002.0	26.5	78	304	9.0	22213
M016	20111129 01:01	−5.110	78.096	1004.0	27.1	81	293	8.0	24553
M017	20111129 04:01	−5.105	78.090	1006.4	25.1	90	300	10.2	23406
M018	20111129 07:03	−5.128	78.102	1004.9	26.8	79	303	10.4	22816
M019	20111129 10:00	−5.074	78.082	1002.6	28.0	74	297	9.4	23133
M020	20111129 12:59	−5.101	78.127	1004.1	28.0	77	296	6.9	23013

(*1) Due to bad telemetry, the data is very sparse, especially above 3000m height.

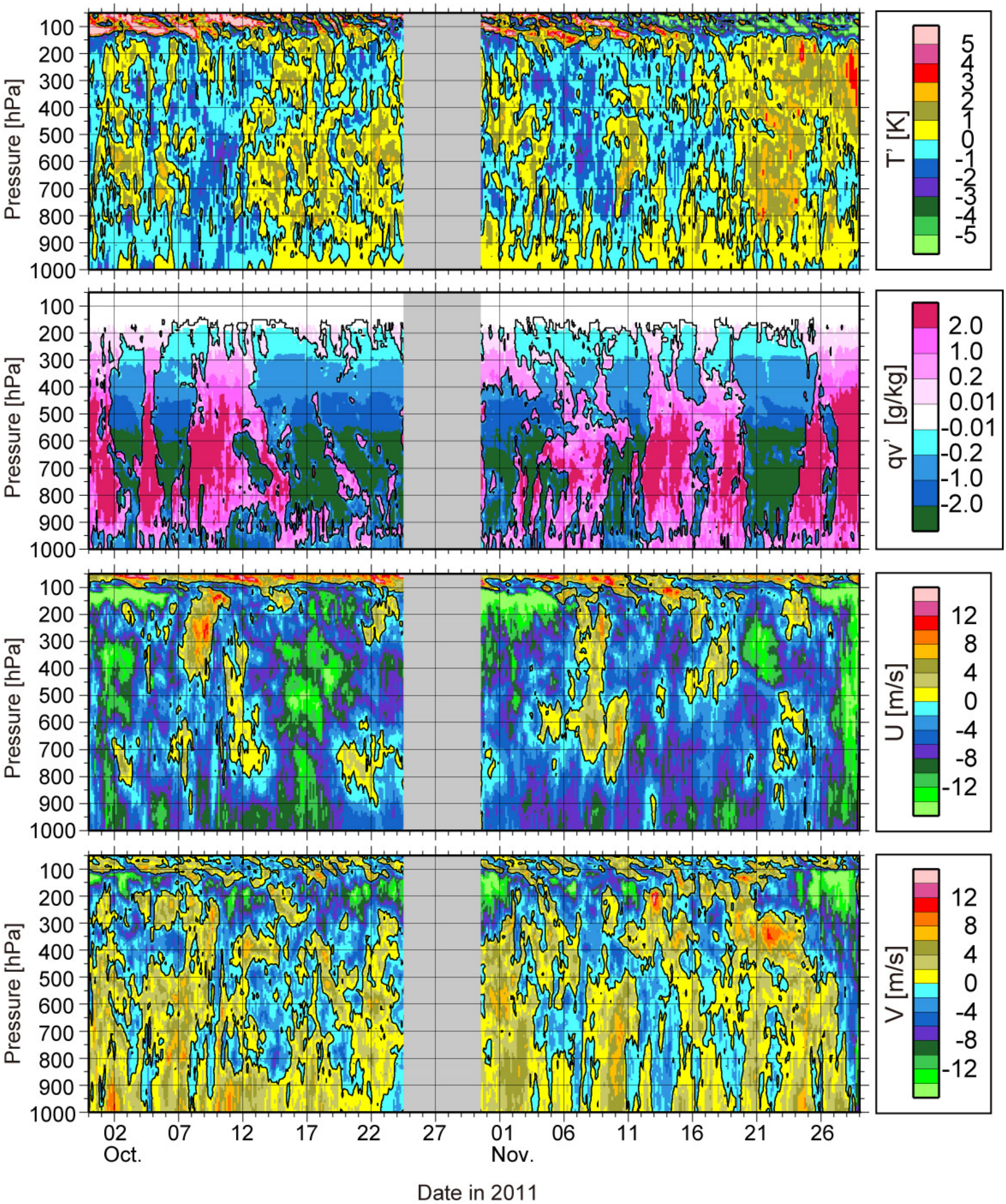


Fig. 5.1-1: Time-height cross sections of observed parameters at (8S, 80.5E); (a) temperature, in anomaly to the period-averaged value at each pressure level, (b) water vapor mixing ratio, in anomaly to the period-averaged value at each pressure level, (c) zonal wind (absolute value), and (d) meridional wind (absolute value). The gray shade indicates the period when Mirai was not at (8S, 80.5E) for port call at Colombo.

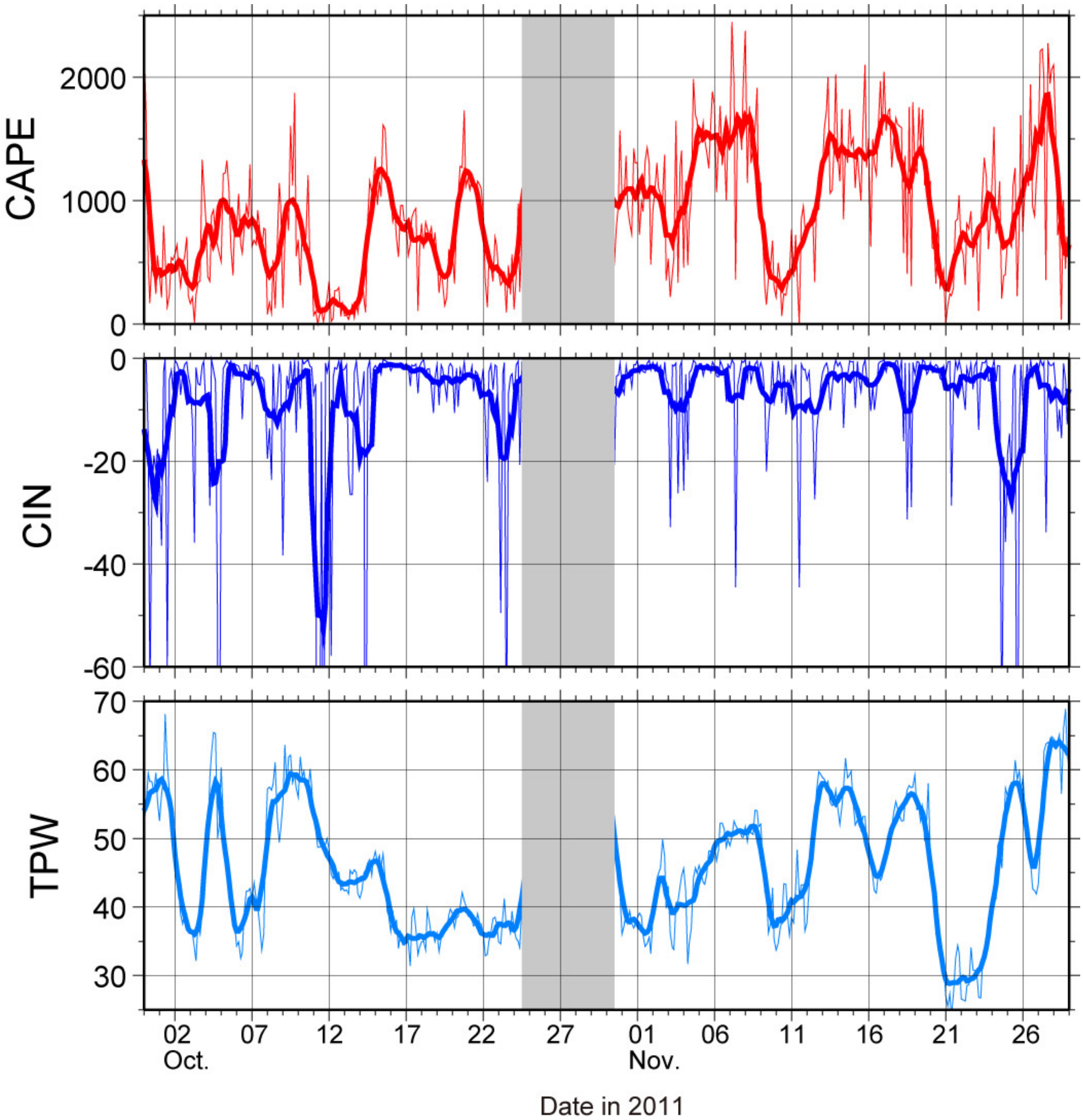


Fig. 5.1-2: Time series of the parameters derived from the radiosonde observations; (a) CAPE, (b) CIN, and (c) precipitable water. The thin lines are from the 3-hourly snapshots, while the thick lines are the running mean for 25 hours. The gray shade indicates the period when Mirai was not at (8S, 80.5E) for port call at Colombo.

5.2 Doppler Radar

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio YONEYAMA*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki KATSUMATA***	(JAMSTEC)	- Principal Investigator (Leg-2)
Kazuaki YASUNAGA**	(JAMSTEC)	
Mariko SEKI**	(JAMSTEC)	
Keisuke TASHIRO**	(JAMSTEC)	
Ayumi KUROTAKI*	(JAMSTEC)	
Aya TSUBOI*	(Kyoto Univ.)	
Nao TAKAMURA*	(Kyoto Univ.)	
Tetsuya TAKEMI	(Kyoto Univ.)	- not on board
Taro SHINODA	(Nagoya Univ.)	- not on board
Souichiro SUEYOSHI***	(GODI)	- Operation Leader (Leg-1 and 2)
Asuka DOI***	(GODI)	
Toshimitsu GOTO***	(GODI)	
Katsuaki MAENO*	(GODI)	
Ryo KIMURA*	(GODI)	
Satoshi OKUMURA**	(GODI)	
Kazuho YOSHIDA**	(GODI)	
Wataru TOKUNAGA***	(MIRAI Crew)	

(2) Objective

The objective of the Doppler radar observation in this cruise is to investigate three dimensional rainfall and kinematic structures of precipitation systems and their temporal and special variations in the central Indian Ocean, especially at around (8S, 80.5E).

(3) Method

The Doppler radar on board of Mirai is used. The specification of the radar is:

Frequency:	5290 MHz
Beam Width:	less than 1.5 degrees
Output Power:	250 kW (Peak Power)
Signal Processor:	RVP-7 (Vaisala Inc. Sigmet Product Line, U.S.A.)
Inertial Navigation Unit:	PHINS (Ixsea S.A.S., France)
Application Software:	IRIS/Open (Vaisala Inc. Sigmet Product Line, U.S.A.)

Parameters of the radar are checked and calibrated at the beginning and the end of the intensive observation. Meanwhile, daily checking is performed for (1) frequency, (2) mean output power, (3) pulse width, and (4) PRF (pulse repetition frequency).

During the cruise, the volume scan consisting of 21 PPIs (Plan Position Indicator) is conducted every 10 minutes. A dual PRF mode with the maximum range of 160 km is used for the volume scan. Meanwhile, a surveillance PPI scan is performed every 30 minutes in a single PRF mode with the maximum range of 300 km. At the same time, RHI (Range Height Indicator) scans of the dual PRF mode are also operated whenever detailed vertical structures are necessary in certain azimuth directions. Detailed information for each observational mode is listed in Table 5.2-1. The Doppler radar observation is from Sep.25 to Oct.26, 2011 during the Leg 1, and from Oct.29 to Dec.01, 2011 during the Leg 2.

Table 5.2-1 Parameters for each observational mode

	Surveillance PPI	Volume Scan	RHI
Pulse Width	2 (microsec)	0.5 (microsec)	0.5 (microsec)
Scan Speed	18 (deg/sec)	18 (deg/sec)	Automatically determined
PRF	260 (Hz)	900/720 (Hz)	900 (Hz)
Sweep Integration	32 samples	50 samples	32 samples
Ray Spacing	1.0 (deg)	1.0 (deg)	0.2 (deg)
Bin Spacing	250 (m)	250 (m)	250 (m)
Elevation Angle	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 60.0
Azimuth	Full Circle	Full Circle	Optional
Range	300 (km)	160 (km)	160 (km)

(4) Preliminary results

Figure 5.2-1 shows the time series of the areal coverage of the radar echo greater than 10 dBZ, obtained by the volume scans, during the period when Mirai was staying at (8S, 80.5E). As in the figure, the Leg-1 (Sep.30 to Oct.24) is clearly separated as former “convectively active” period and latter “convectively inactive” period. On the other hand in the Leg-2 (Oct.31 to Nov.28), the certain amount of radar echo was appeared for the most of the observation time. Somewhat periodic variations, with the cycle of several days, or diurnal cycle, are apparent. The lower panel indicate that the large coverage was mostly contributed by the extension of stratiform precipitating area. The further detailed analyses will be studied soon.

(5) Data archive

All data of the Doppler radar observation during this cruise will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG). The corrected datasets will be available at Mirai website at http://www.jamstec.go.jp/cruisedata/mirai/e/, and CINDY website.

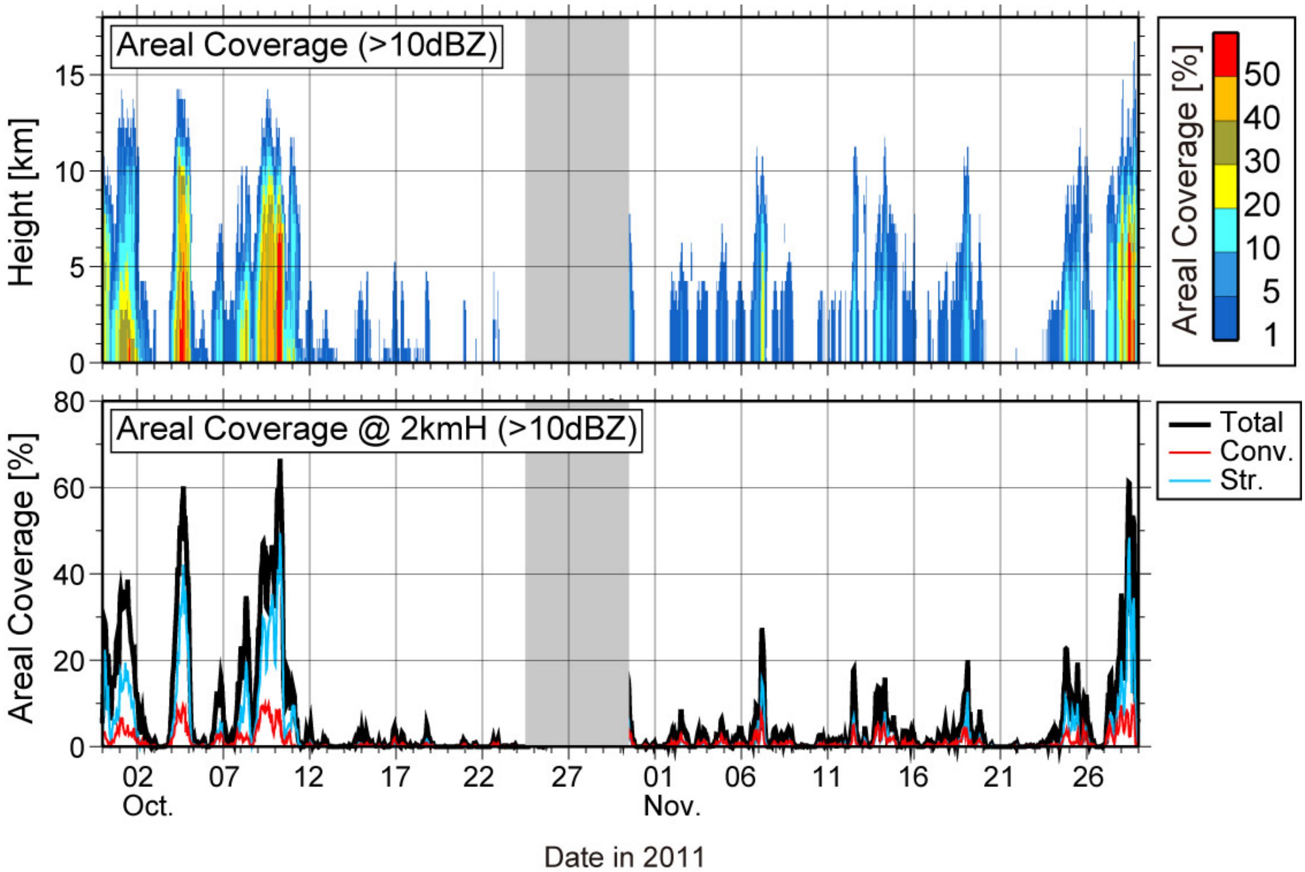


Fig. 5.2-1: Time series of the areal coverage of the radar echo greater than 10 dBZ; (upper) vertical profile, and (lower) at 2 km height, with value for convective (red) and stratiform (blue) portions.

5.3 Didrometer

(1) Personnel

Masaki KATSUMATA (JAMSTEC) - Principal Investigator (Leg-1 and 2)

(2) Objectives

The disdrometer can continuously obtain size distribution of raindrops (in 20 categories) and rainfall intensity. The objective of this observation is (a) to reveal microphysical characteristics of the rainfall, depends on the type, temporal stage, etc. of the precipitating clouds, and (b) to retrieve the coefficient to convert radar reflectivity (especially from Doppler radar in Section 5.2) to the rainfall amount.

(3) Methods

The “Joss-Waldvogel-type” disdrometer system (RD-80, Disdromet Inc.) was utilized. The system equipped a microphone on the top of the sensor unit. When a raindrop hit the microphone, the magnitude of induced sound is converted to the size of raindrops. The logging program “DISDRODATA” determines the size as one of the 20 categories as in Table 5.3-1, and accumulates the number of raindrops at each category. The rainfall amount could be also retrieved from the obtained drop size distribution. The number of raindrops in each category, and converted rainfall amount, are recorded every one minute.

The disdrometer was installed on the roof of the unti-rolling system of R/V Mirai, as in Fig. 5.3-1. The data was obtained over the high seas throughout the cruise.

Table 5.3-1: Category number and corresponding size of the raindrop.

Category	Corresponding size range [mm]		
1	0.313	-	0.405
2	0.405	-	0.505
3	0.505	-	0.696
4	0.696	-	0.715
5	0.715	-	0.827
6	0.827	-	0.999
7	0.999	-	1.232
8	1.232	-	1.429
9	1.429	-	1.582
10	1.582	-	1.748
11	1.748	-	2.077
12	2.077	-	2.441
13	2.441	-	2.727
14	2.727	-	3.011
15	3.011	-	3.385
16	3.385	-	3.704
17	3.704	-	4.127
18	4.127	-	4.573
19	4.573	-	5.145
20	5.145	or larger	

(4) Preliminary Results

Figure 5.3-2 displays the time series of the measured rainrate and accumulated. The temporal variation reasonably corresponds to the radar-observed echo coverage as shown in Fig. 5.2-1 (see Section 5.2).

(5) Data Archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG). The corrected datasets will be available at CINDY website.

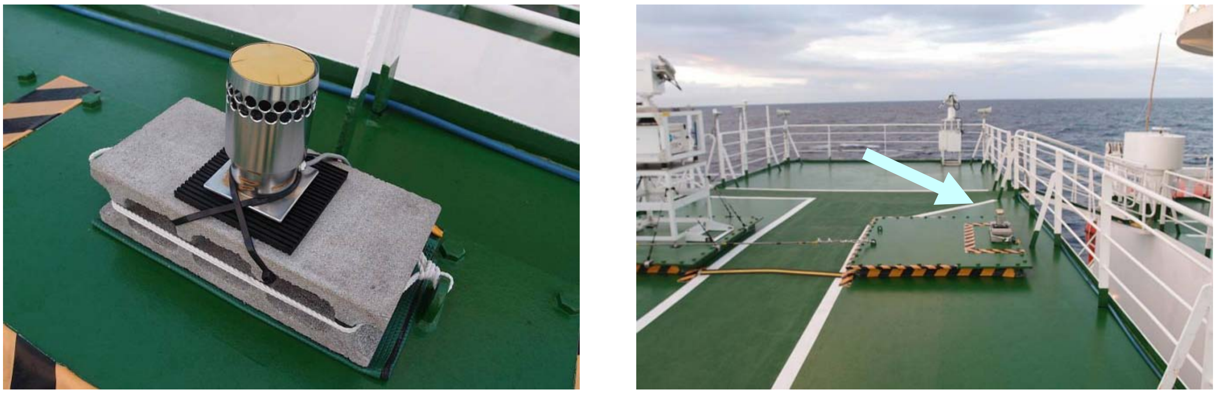


Fig. 5.3-1: Sensor unit (left) and its installed location (right, arrowed).

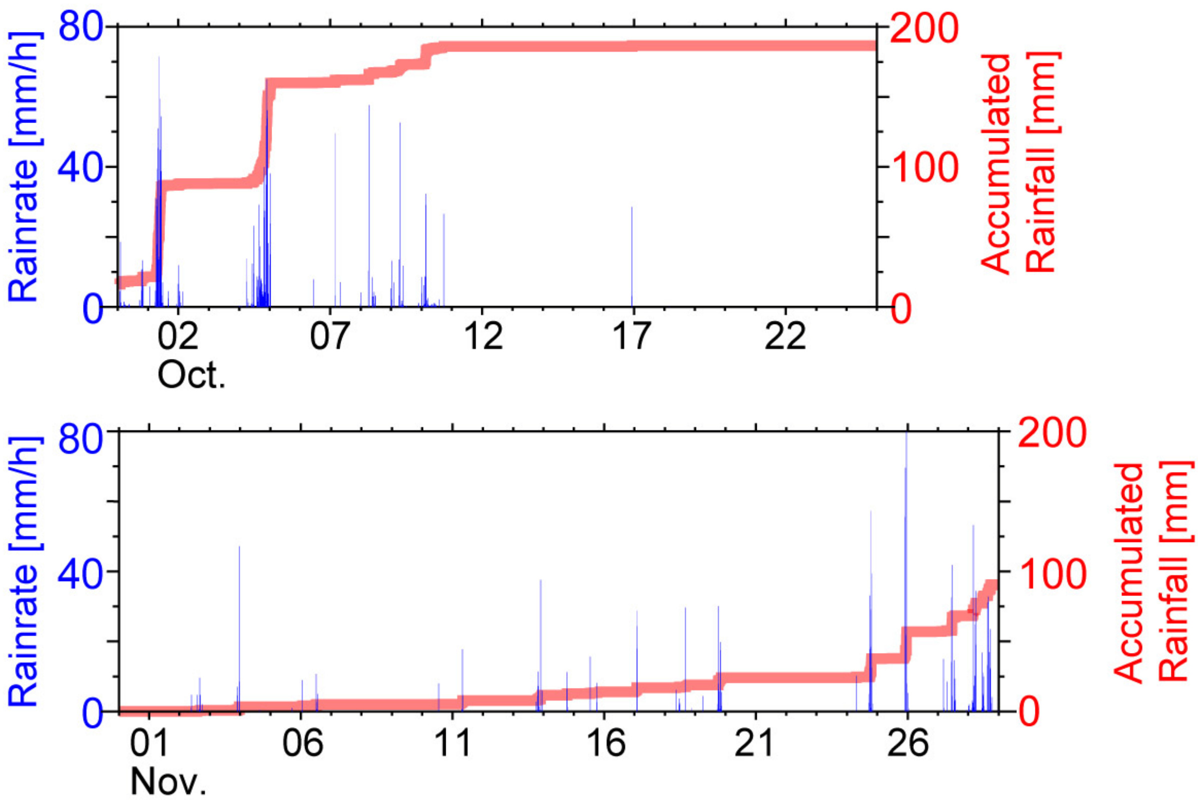


Fig. 5.3-2: Time series of the rainrate at every minute (blue vertical bars) and accumulated rainfall amount (red line) measured by the disdrometer, for the periods of stationary observation at (8S, 80.5E) during Leg-1 (upper) and Leg-2 (lower).

5.4 95GHz cloud profiling radar

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

TAKANO Toshiaki	(Chiba University)	- Principal Investigator (not on board)
NISHINO Daichi	(Chiba University)	- not on board
OHKURA Tetsuya*	(Chiba University)	
TASHIRO Keisuke**	(Chiba University)	
NAKAURA Fumiaki	(Chiba University)	- not on board
NISHIZAWA Tomoaki*	(NIES)	
MATSUI Ichiro**	(NIES)	
SUGIMOTO Nobuo	(NIES)	- not on board
OKAMOTO Hajime	(Kyushu University)	- not on board

(2) Objective

Main objective for the 95GHz cloud radar named FALCON-I is to detect vertical structure of cloud and precipitation and Doppler spectra of the observed targets. 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) Observations and products

Observation with FALCON-I was done continuously with 10 sec repetition cycle during the cruise. Basic output from data is cloud occurrence, radar reflectivity factor, and Doppler spectra. Sensitivity of FALCON-I is about -32 dBZ and its spacial resolution is about 15m at 5 km height. Doppler spectra were also obtained with 10 sec temporal resolution in ±3.1 m/s.

Detectabilities of clouds, however, were degradated during the cruise in 10-20 dB because of decrease of radar output power.

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 by H.Okamoto, Kyushu 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) Example of Data

An example of the time height cross-sections of radar reflectivity power is shown in Fig.5.4-1.

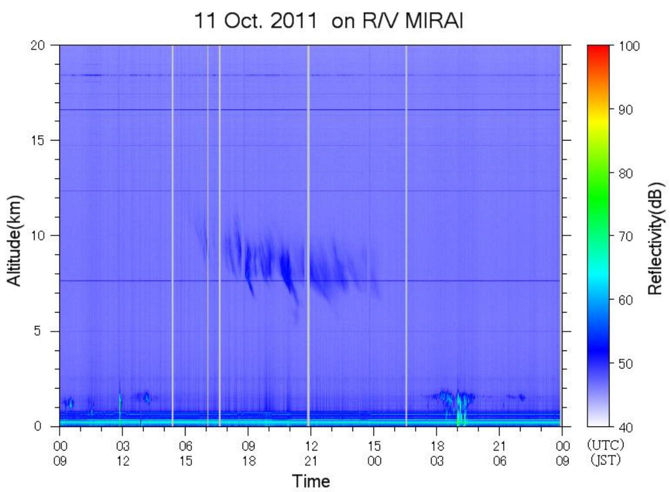


Fig 5.4-1. Time height cross section of radar reflectivity power in arbitral unit of dB on 11 October, 2011. The location of MIRAI was around 8S, 80.5E. We can recognize clouds at 7-11 km in height.

5.5 Lidar observations of clouds and aerosols

(1) Personnel

Tomoaki NISHIZAWA	(NIES)	- Principal Investigator (Leg-1)
Ichiro MATSUI	(NIES)	- Principal Investigator (Leg-2)
Nobuo SUGIMOTO	(NIES)	- not on board
Atsushi SHIMIZU	(NIES)	- not on board

(2) Objectives

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 polarization Mie lidar and a high-spectral resolution lidar (HSRL).

(3) Method

<u>(3-1) Mie lidar</u>

Vertical profiles of aerosols and clouds are measured with a two-wavelength polarization Mie lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064nm and the second harmonic at 532nm. Transmitted laser energy is typically 30mJ per pulse at both of 1064 and 532nm. The pulse repetition rate is 10Hz. 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 532nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064nm, 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 minutes vertical profiles of four channels (532 parallel, 532 perpendicular, 1064, 532 near range) are recorded. The data was available for following periods:

Leg1) September 26, 2011 - October 25, 2011
Leg2) October 30, 2011 – Nov. 30, 2011

<u>(3-2) HSRL</u>

Vertical profiles of aerosols, clouds, and water vapor are measured with a HSRL. The lidar employs an injection-seeded Nd:YAG laser at 532 and 1064nm in narrower line width than the laser used in the Mie lidar. Transmitted laser energy is more than 100mJ per pulse at both of 1064 and 532nm. The pulse repetition rate is 10Hz. The receiver telescope has a diameter of 30 cm. The receiver has six detection channels: parallel and perpendicular polarization components of lidar signals at 532 and 1064nm, Raman scatter signals at 660nm for water vapor detection, and Rayleigh scatter signals at 532nm using a HSRL technique. APDs are used for 1064nm channels, and PMTs are used for 532 and 660nm. 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 having a glass window on the roof, and the lidar was operated continuously regardless of weather. Every 1 minute profiles of six channels are recorded. The data was available for following periods:

Leg1) October 1. 2011 - October 25, 2011
Leg2) October 30, 2011 – Nov. 30, 2011

(4) Results

Temporal and vertical distributions of 532nm lidar signals measured with the two wavelength polarization Mie lidar are depicted in Fig. 5.5-1 for the Leg-1 cruise period and in Fig. 5.5-2 for the Leg-2 cruise period. The figures show that the lidar can detect maritime aerosols in the planetary boundary layer (PBL) formed below 1km, water clouds formed at the top of the PBL, ice clouds in the upper layer and rain falling from clouds, indicating that appropriate lidar measurements could be conducted. Especially, it should be noted that the lidar could detect ice clouds (cirrus) up to very high altitude of 17km since optical and microphysical properties and distributions of cirrus are key parameters for evaluating climate change.

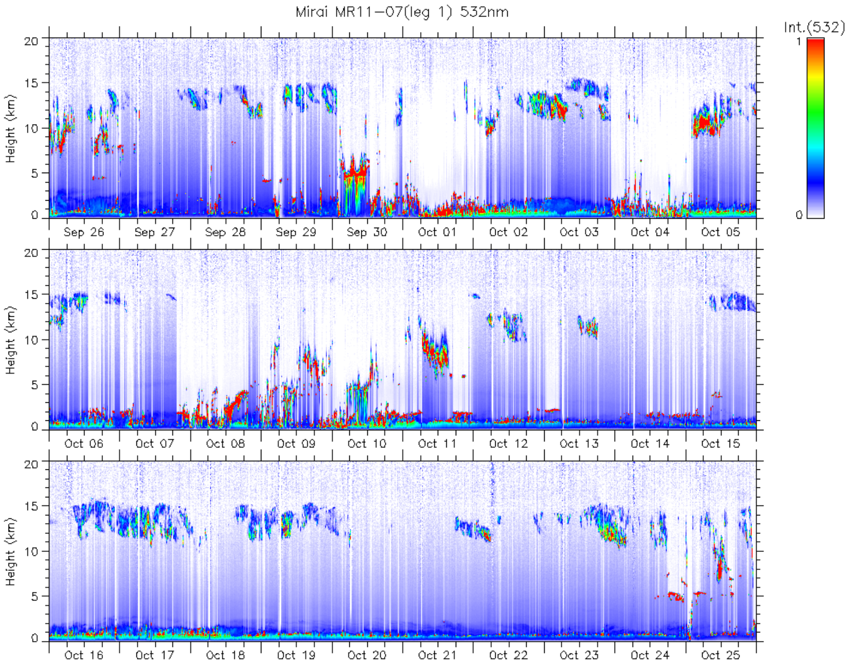


Fig. 5.5-1: Time-height sections of backscatter intensity at 532nm from 26 September 2011 to 25 October 2011 in the Leg 1 cruise.

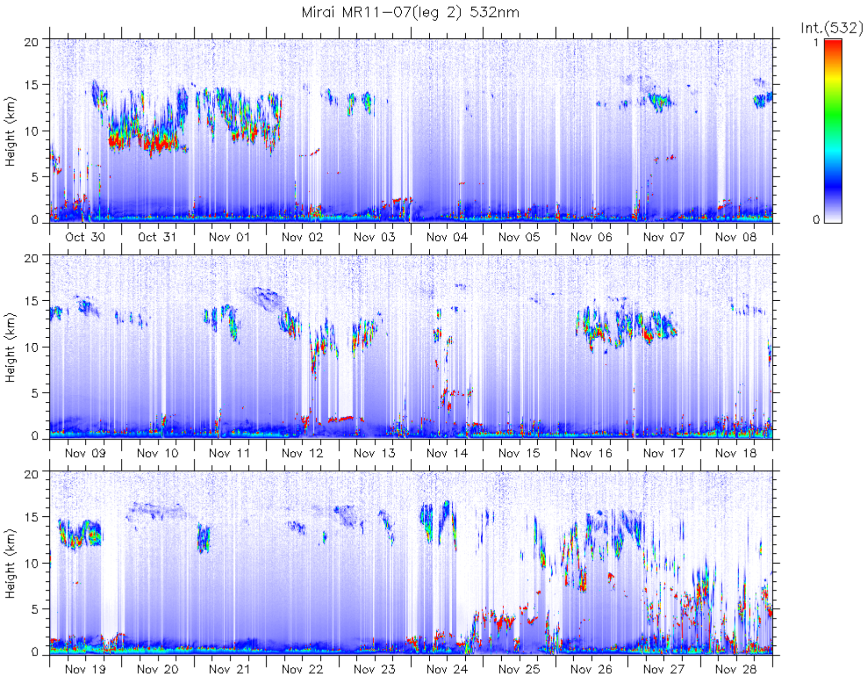


Fig. 5.5-2: Same as Fig. 5.5-1, but from 30 October 2011 to 27 November 2011 in the Leg 2 cruise.

As examples of the HSRL measurements, we show the results on Oct. 5 in the Leg 1 cruise period in Fig. 5.5-3. Total signals at 532nm and 1064nm indicate the existence of maritime aerosols in the PBL formed below 1km, water clouds formed at the top of the PBL, and ice clouds in the upper layer between 10km and 15km. Values of total depolarization ratio at 532nm and spectral ratio of the total signals at 532 and 1064nm (i.e., 1064nm/532nm) for the ice clouds are consistent with results of previous observational studies, indicating that the appropriate lidar measurement could be conducted. The HSRL technique used in this system blocks light scattered by particles (i.e., clouds and aerosols) and transmits light scattered by molecules (i.e., Rayleigh backscatter signals) using an iodine absorption filter and the laser with narrow line width. The signals measured by using the HSRL technique (532nm Ray) decreased in the clouds, indicating that the HSRL system worked well. Raman scatter signals by water vapor (WVraman) were also measured in nighttime (i.e., from 12UTC to 24UTC). We preliminarily compared some vertical profiles of water vapor density derived from the Raman scatter signals with those measured with radio sonde, and we found that the profiles roughly matched.

We further show the results on Nov. 22 in the Leg 2 cruise period in Fig. 5.5-3. The measured signals are appropriate similar to those on Oct. 5. On this day, we could catch optically very thin ice clouds at the altitude of 16km almost all day. Some researchers have reported existence of optically very thin cirrus (called as ‘sub-visible cirrus’). Since optical and microphysical properties of sub-visible cirrus have not known well, we can contribute to improving our knowledge for the sub-visible cirrus.

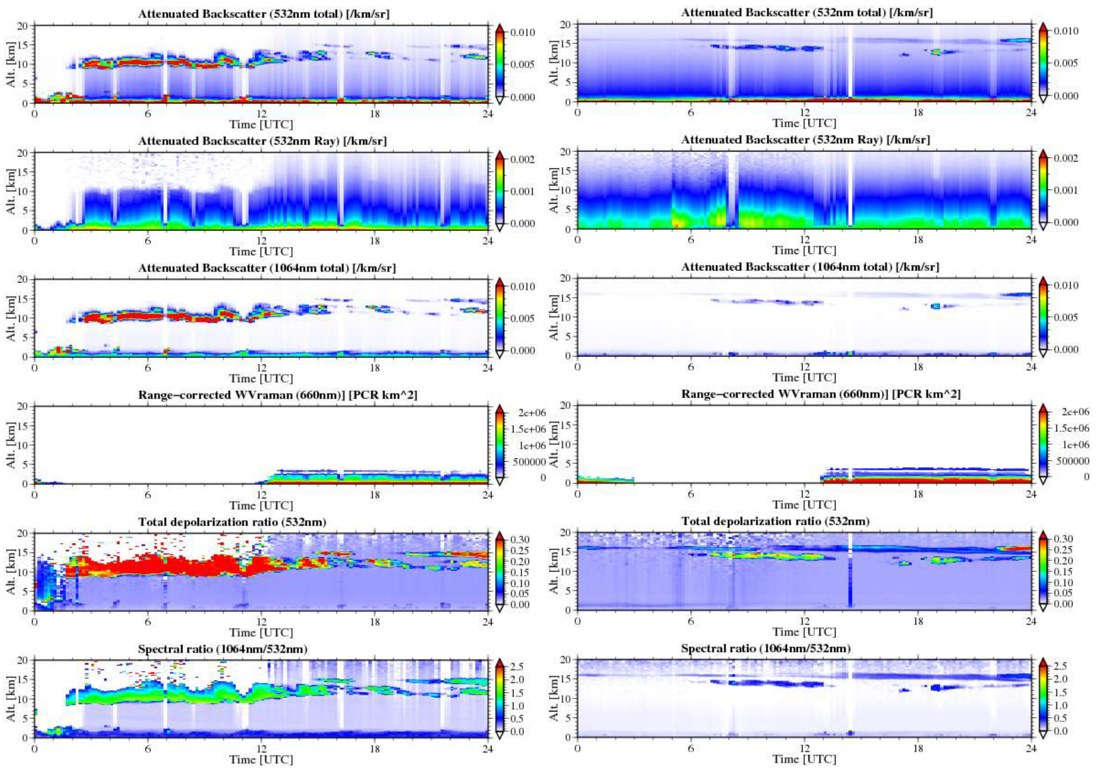


Fig. 5.5-3: Time-height sections of total attenuated backscatter coefficient at 532nm (532nm total), Rayleigh attenuated backscatter coefficient at 532nm (532nm Ray), total attenuated backscatter coefficient at 1064nm (1064nm total), water-vapor Raman scatter signals (WVraman), total depolarization ratio at 532nm, and spectral ratio of total attenuated backscatter coefficients (1064nm/532nm). [Left figure] 5 October, 2011 in the Leg 1 cruise. [Right figure] 22 November, 2011 in the Leg 2 cruise.

(5) Data archive

Contact NIES lidar team (nsugimot/i-matsui/shimizua/nisizawa@nies.go.jp) to utilize lidar data for productive use. The following parameters are / will be available.

Mie lidar

- raw data
    - lidar signal at 532 nm
    - lidar signal at 1064 nm
    - depolarization ratio at 532 nm
    - temporal resolution 10min/ vertical resolution 6 m
- processed data (plan)
    - 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

HSRL

- raw data (plan)
    - lidar signal at 532 nm
    - lidar signal at 1064 nm
    - depolarization ratio at 532 nm
    - depolarization ratio at 1064 nm
    - Rayleigh backscatter signal at 532nm
    - Raman backscatter signal at 660nm
    - temporal resolution 1min/ vertical resolution 3.75 m
- processed data (plan)
    - extinction coefficient at 532nm
    - backscatter coefficient at 532nm
    - backscatter coefficient at 1064nm
    - depolarization ratio at 532nm
    - depolarization ratio at 1064nm
    - water vapor concentration

(6) Acknowledgments

Lidar operation was supported by Global Ocean Development Inc.

5.6 Ceilometer

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio YONEYAMA*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki KATSUMATA***	(JAMSTEC)	- Principal Investigator (Leg-2)
Souichiro SUEYOSHI***	(GODI)	- Operation Leader (Leg-1 and 2)
Asuka DOI***	(GODI)	
Toshimitsu GOTO***	(GODI)	
Katsuaki MAENO*	(GODI)	
Ryo KIMURA*	(GODI)	
Satoshi OKUMURA**	(GODI)	
Kazuho YOSHIDA**	(GODI)	
Wataru TOKUNAGA***	(MIRAI Crew)	

(2) Objectives

The information of cloud base height and the liquid water amount around cloud base is important to understand the process on formation 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 ceilometer (CT-25K, VAISALA, Finland). Major parameters for the measurement configuration are as follows;

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

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

(4) Preliminary results

Fig.5.6-1 shows the time series of the lowest, second and third cloud base height during the cruise.

(5) Data archives

The raw data obtained during this cruise will be submitted to the Data Management Group (DMG) of JAMSTEC.

(6) Remarks (Times in UTC)

1) The observation was carried out within following periods.

Leg1: 12:00 25th Sep. 2011 to 00:00 26th Oct. 2011

Leg2: 00:00 29th Oct. 2011 to 03:00 1st Dec. 2011

2) Window was cleaned at following time.

00:45 23rd Sep. 2011

08:40 25th Sep. 2011

10:50 10th Oct. 2011

05:25 - 05:27 20th Oct. 2011

03:11 - 03:12 25th Oct. 2011

02:16 2nd Nov. 2011

01:48 10th Nov. 2011

04:13 - 04:14 11th Nov. 2011

01:43 25th Nov. 2011

3) The following time, data is not available.

05:32 9th Oct. 2011

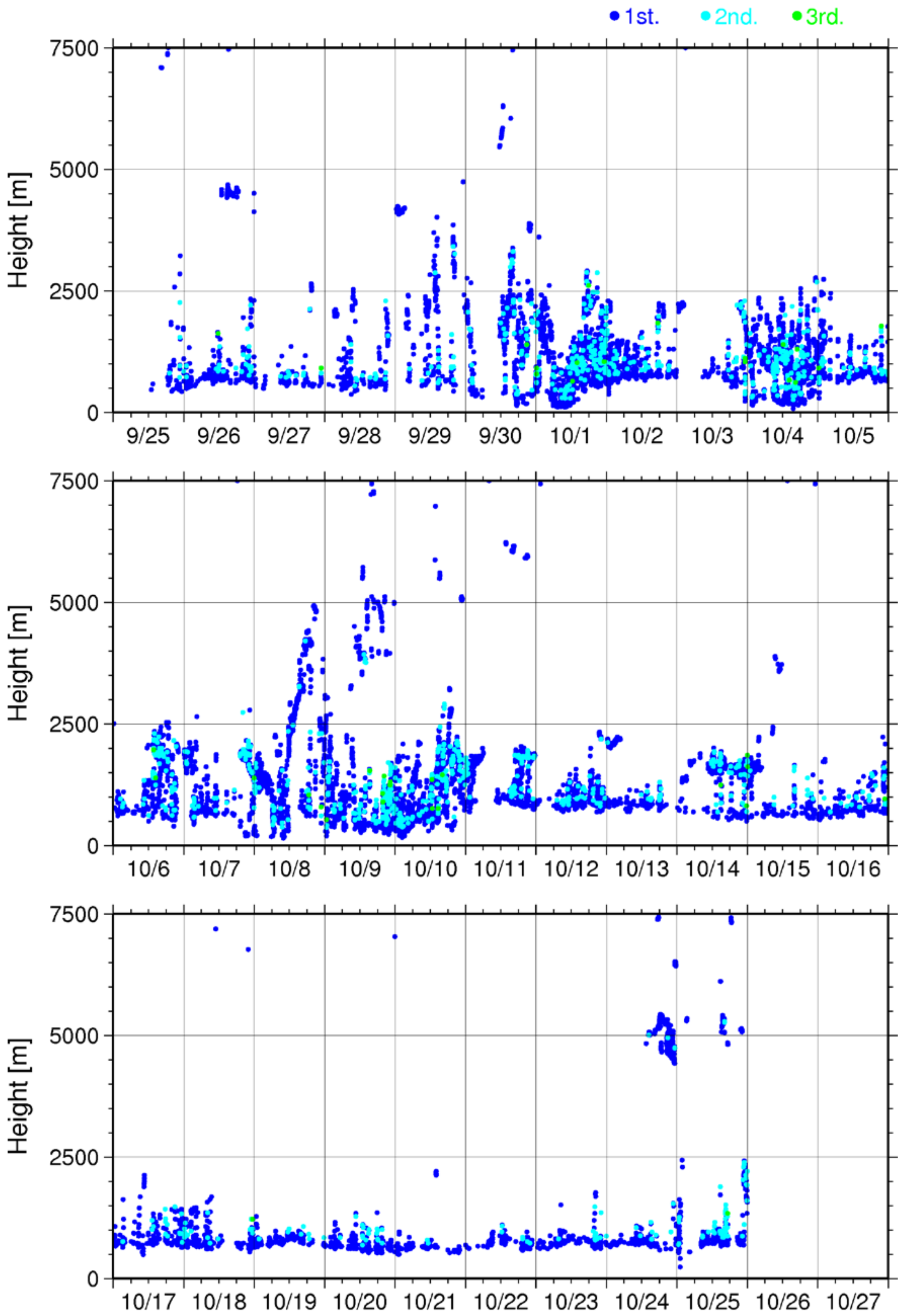


Fig. 5.6-1 First, 2nd and 3rd lowest cloud base height during the MR11-07 cruise.

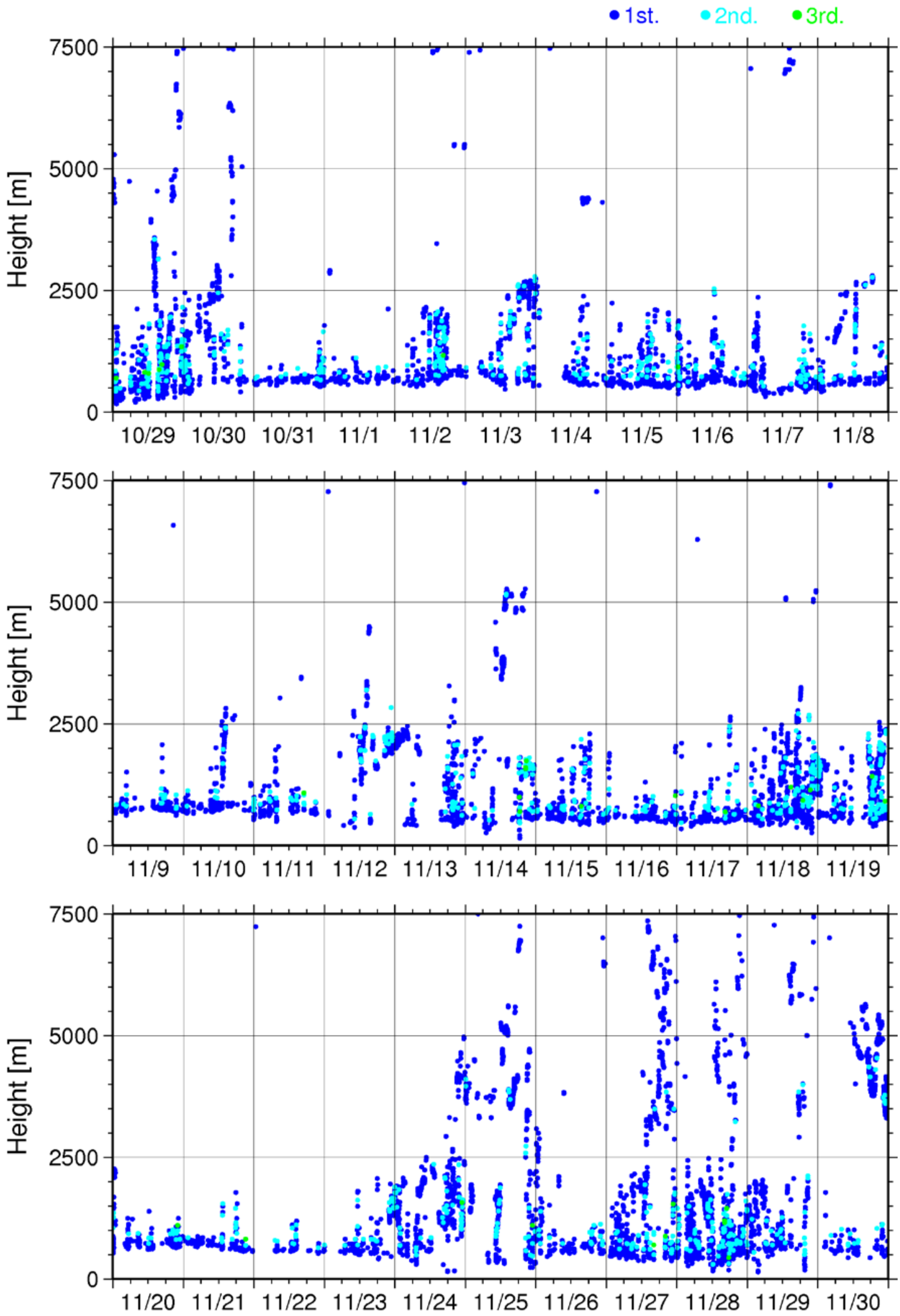


Fig. 5.6-1 (continued)

5.7 GPS meteorology

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kazuaki YASUNAGA** (JAMSTEC) - Principal Investigator (Leg-1 and 2)
Kunio YONEYAMA* (JAMSTEC)
Masaki KATSUMATA*** (JAMSTEC)

(2) Objective

Getting the GPS satellite data to estimate 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 all thru the cruise.

(4) Results

We will calculate the total column integrated water from observed GPS satellite data after the cruise.

(5) Data archive

Raw data is recorded as RINEX format every 5 seconds during ascent. These raw datasets are available from Kazu. Yasunaga of JAMSTEC. Corrected data will be submitted to JAMSTEC Marine-Earth Data and Information Department and will be archived there. A List of raw data files is as follows.

File name	File size
1111290000A.T02	7.852 MB
1111280000A.T02	7.812 MB
1111270000A.T02	7.574 MB
1111260000A.T02	7.520 MB
1111250000A.T02	7.828 MB
1111240000A.T02	7.655 MB
1111230000A.T02	7.546 MB
1111220000A.T02	7.811 MB
1111210000A.T02	7.756 MB
1111200000A.T02	7.668 MB
1111190000A.T02	7.746 MB
1111180000A.T02	7.670 MB
1111170000A.T02	7.717 MB
1111160000A.T02	7.784 MB
1111150000A.T02	7.776 MB
1111140000A.T02	7.865 MB
1111130000A.T02	7.734 MB
1111120000A.T02	7.716 MB
1111110000A.T02	7.692 MB

1111100000A.T02	7.471 MB
1111090000A.T02	7.651 MB
1111080000A.T02	7.825 MB
1111070000A.T02	7.732 MB
1111060000A.T02	7.675 MB
1111050000A.T02	7.659 MB
1111040000A.T02	7.818 MB
1111030000A.T02	7.724 MB
1111020000A.T02	7.647 MB
1111010000A.T02	7.713 MB
1110310000A.T02	7.582 MB
1110310000A.T02	7.582 MB
1110300000A.T02	7.819 MB
1110290000A.T02	7.763 MB
1110250000A.T02	7.598 MB
1110240000A.T02	7.175 MB
1110230000A.T02	7.348 MB
1110220000A.T02	7.394 MB
1110210000A.T02	7.537 MB
1110200000A.T02	7.646 MB
1110190000A.T02	7.607 MB
1110180000A.T02	7.609 MB
1110170000A.T02	7.815 MB
1110160000A.T02	7.789 MB
1110150000A.T02	7.810 MB
1110140000A.T02	7.626 MB
1110130000A.T02	7.455 MB
1110120000A.T02	7.724 MB
1110110000A.T02	7.629 MB
1110100000A.T02	7.669 MB
1110090000A.T02	7.639 MB
1110080000A.T02	7.711 MB
1110070000A.T02	7.637 MB
1110060000A.T02	7.587 MB
1110050000A.T02	7.646 MB
1110040000A.T02	7.591 MB
1110030000A.T02	7.576 MB
1110020000A.T02	7.601 MB
1110010000A.T02	7.672 MB
1109300000A.T02	7.987 MB
1109290000A.T02	7.919 MB
1109280000A.T02	7.573 MB
1109270000A.T02	7.718 MB
1109260000A.T02	7.515 MB

5.8 Water-vapor and ozone soundings

(1) Personnel

Masatomo FUJIWARA	(Hokkaido University)	- Principal Investigator (not on board)
Junko SUZUKI	(JAMSTEC)	- on board (Leg-1 and 2)
Fumio HASEBE	(Hokkaido Univ.)	- not on board
Masato SHIOTANI	(Kyoto Univ.)	- not on board
Takashi SHIBATA	(Nagoya Univ.)	- not on board

(2) Objective

The research objective is to investigate the transport and dehydration processes around the tropical tropopause. A total of 20 sets of the Development measurement technologies Cryogenic Frostpoint Hygrometer, 10 sets of the EN-SCI electrochemical concentration cell (ECC) ozonesonde, and 20 sets of the Meisei RS06G radiosonde are flown with meteorological rubber balloons to obtain water vapor and ozone profiles up to the middle stratosphere.

(3) Methods

The payload consists of the following four parts:

Cryogenic Frostpoint Hygrometer（CFH）
(Development measurement technologies, Corp., USA)
ECC ozonesonde: Standard ozonesonde using potassium iodide solutions
(Development measurement technologies, Corp., USA)
RS06G: Standard radiosonde
(Meisei, Corp., Japan)

The payload is flown with the TA1200 rubber balloon, 160 or 190 type parachute, and unwinder (TOTEX, Japan). The Helium gas is used to obtain the buoyancy of about 5 m/s ascent. The CFH sensor is injected the cryogen refrigerated ~80º C by a deep freezer in the No.1 Chemistry/Biology Laboratory.

The ground receiving system consists of a Meisei GPS sounding receiver system (RS-08AC), Brown antenna, and laptop computer. Software “MGPS_R” developed at Meisei is used for calculation, real-time graphics, and data storage. The antenna was installed around the top of the Main Mast, and the receiving system together with the ozonesonde preparation system was installed in the Aft Wheel House.

The following table shows the sounding date and time.

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

5 Oct. 10:25	19 Oct. 10:20	21 Oct. 10:15	1 Nov. 10:01	2 Nov. 10:45
3 Nov. 10:03	4 Nov. 7:51	5 Nov. 7:50	6 Nov. 19:50	7 Nov. 20:02
*10 Nov. 9:57	*15 Nov. 7:51	*16 Nov. 7:46	*17 Nov. 7:44	*18 Nov. 10:23
*20 Nov. 7:45	*21 Nov. 9:54	*22 Nov. 7:42	*24 Nov. 9:55	*26 Nov. 7:39

*with the ECC ozonesonde

The balloon inflation was made at the backside of the upper deck where the launch was made. We used a balloon protection cover during the inflation. The frequency range of 404.0 MHz was used for the radiosonde transmitter.

(4) Preliminary results

The CFH is capable of measuring water vapor inside clouds but may occasionally suffer from an artifact in which the optical detector collects water of ice. The condition leas to a malfunction of the instrument controller and thus needs to be screened out of the processed data [Selkrik et al., 2010]. Therefore we could not show here the vertical distributions of temperature, ozone, relative humidities, and the CFH as house-keeping profiles. All but three ascents reached altitudes of 29 km or more. The cold-point tropopause was around 17 km during this cruise.

(5) Data Archive

All data obtained during this cruise will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG). The corrected datasets will be available at CINDY website.

5.9 Ship-borne sky radiometer

(1) Personnel

Kazuma AOKI	(University of Toyama)	- Principal Investigator / not onboard
Tadahiro HAYASAKA	(Tohoku University)	- Co-Investigator / not onboard
Masataka SHIOBARA	(NIPR)	- Co-Invectigator / not onboard

(2) Objectives

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

(3) Methods and Instruments

Sky radiometer is measuring the direct solar irradiance and the solar aureole radiance distribution, has seven interference filters (0.34, 0.4, 0.5, 0.675, 0.87, 0.94, and 1.02 μm). Analysis of these data is performed by SKYRAD.pack version 4.2 developed by Nakajima *et al*. (1996).

@ Measured parameters

① Aerosol optical thickness at five wavelengths (400, 500, 675, 870 and 1020 nm)
② Ångström exponent
③ Single scattering albedo at five wavelengths
④ 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.

(4) Preliminary results

This study is not onboard. Data obtained in this cruise will be analyzed at University of Toyama.

(5) Data archives

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

(6) Acknowledgment

The operations were supported by Global Ocean Development Inc.

5.10 Tropospheric aerosol and gas observations by MAX-DOAS and auxiliary techniques

(1) Personnel

Hisahiro TAKASHIMA	(PI, JAMSTEC/RIGC, not on board)
Fumikazu TAKETANI	(JAMSTEC/RIGC, not on board)
Hitoshi IRIE	(JAMSTEC/RIGC, not on board)
Yugo KANAYA	(JAMSTEC/RIGC, not on board)

(2) Objectives

- To quantify typical background values of atmospheric aerosol and gas over the ocean
- To clarify transport processes from source over Asia to the ocean (and also clarify the gas emission from the ocean (including organic gas))
- To validate satellite measurements as well as chemical transport model
- To clarify aerosol/gas variation associated with equatorial waves/ISO/MJO.

(3) Methods

(3-1) MAX-DOAS

Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) is a passive remote sensing technique designed for atmospheric aerosol and gas profile measurements using scattered visible and ultraviolet (UV) solar radiation at several elevation angles. Our MAX-DOAS instrument for R/V *Mirai* consists of two main parts: an outdoor telescope unit and an indoor spectrometer (Acton SP-2358 with Princeton Instruments PIXIS-400B). These two parts are connected by a 14-m bundle cable that consists of 12 cores with 100-mm radii. On the roof top of the anti-rolling system of R/V *Mirai*, the telescope unit was installed on a gimbal mount, which compensates for the pitch and roll of the ship. A sensor measuring pitch and roll of the telescope unit (10Hz) is used together to measure an offset of elevation angle due to incomplete compensation by the active-type gimbal. The line of sight was in directions of the starboard and portside of the vessel.

The MAX-DOAS system records spectra of scattered solar radiation every 0.2-0.4 second. Measurements were made at several elevation angles of 0, 1.5, 3, 5, 10, 20, 30, 70, 110, 150, 160, 170, 175, 177 and 178.5 degrees using a movable mirror, which repeated the same sequence of elevation angles every 30-min. The UV/visible spectra range was changed every minute (284-423 nm and 391-528 nm).

For the spectral analysis, spectra data were selected with a criterion for the elevation angle to be within ±0.2° of the target. For those spectra, DOAS spectral fitting was performed to quantify the slant column density (SCD), defined as the concentration integrated along the light path, for each elevation angle. In this analysis, SCDs of NO_2 (and other gases) and O_4 (O_2-O_2, collision complex of oxygen) were obtained together. Next, O_4 SCDs were converted to the aerosol optical depth (AOD) and the vertical profile of aerosol extinction coefficient (AEC) at a wavelength of 476 nm using an optimal estimation inversion method with a radiative transfer model. Using derived aerosol information, another inversion is performed to retrieve the tropospheric vertical column/profile of NO_2 and other gases.

(3-2) CO, O_3, and aerosol size distribution

Carbon monoxide (CO) and ozone (O_3) measurements were also continually conducted during the cruise. For CO and O_3 measurements, ambient air was continually sampled on the compass deck and drawn through ~20-m-long Teflon tubes connected to gas filter correlation CO analyzer (Model 48C, Thermo Fisher Scientific) and UV photometric based ozone analyzer (Model 49C, Thermo Fisher

Scientific) in the *Research Information Center*. Aerosol size distribution measurements by optical particle counter (KR-12A, Rion) were not conducted due to instrument problems during the cruise.

(4) Preliminary results

These data for the whole cruise period will be analyzed.

(5) Data archives

The data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC after the full analysis of the raw spectrum data is completed, which will be <2 years after the end of the cruise.

5.11 Surface meteorological observations

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio YONEYAMA*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki KATSUMATA***	(JAMSTEC)	- Principal Investigator (Leg-2)
Souichiro SUEYOSHI***	(GODI)	- Operation Leader (Leg-1 and 2)
Asuka DOI***	(GODI)	
Toshimitsu GOTO***	(GODI)	
Katsuaki MAENO*	(GODI)	
Ryo KIMURA*	(GODI)	
Satoshi OKUMURA**	(GODI)	
Kazuho YOSHIDA**	(GODI)	
Wataru TOKUNAGA***	(MIRAI Crew)	

(2) Objectives

Surface meteorological parameters are observed as a basic dataset of the meteorology. These parameters provide the temporal variation of the meteorological condition surrounding the ship.

(3) Methods

Surface meteorological parameters were observed by two systems as follows.

1) *MIRAI Surface Meteorological observation (SMet) system*

Instruments of SMet system are listed in Table 5.11-1 and measured parameters are listed in Table 5.11-2. Data were collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set consists of 6 second averaged data.

2) *Shipboard Oceanographic and Atmospheric Radiation (SOAR) measurement system*

SOAR system designed by BNL (Brookhaven National Laboratory, USA) consists of major five parts.

a) Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.
b) Zeno Meteorological (Zeno/Met) system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.
c) “SeaSnake” the floating thermistor designed by BNL – skin sea surface temperature (SSST) measurement.
d) ISAR (Infrared Sea Surface Temperature Autonomous Radiometer) developed by the School of Ocean and Earth Science (SOES) at the University of Southampton, and adjusted to Mirai by the Remote Measurement and Research Company (RMR) – SSST measurement
e) Scientific Computer System (SCS) developed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

SCS recorded PRP data every 6 seconds, Zeno/Met data every 10 seconds and SeaSnake data every 2 seconds. ISAR data was recorded by another PC, every 5 seconds (raw data) and every 10 minutes (averaged data). Instruments and their locations are listed in Table 5.11-3 and measured parameters are listed in Table 5.11-4.

SeaSnake equipped two thermistor probes. Output voltage was converted to SSST by Steinhart-Hart equation with following coefficients led from the calibration data. See (6) Remarks for the deployed period for each sensors.

Sensor	a	b	c
T01-005 Sensor:	7.97710e-04	-2.13236e-04	-6.70279e-08
T01-100 Sensor:	8.10896e-04	-2.11366e-04	-7.29166e-08
T03-005 Sensor:	7.97750e-04	-2.13058e-04	-6.84900e-08
T03-100 Sensor:	8.04777e-04	-2.12133e-04	-7.11043e-08

y = a + b * x + c * x**3,
x = log (1 / ((Vref / V - 1) * R2 - R1))
T = 1 / y - 273.15

Vref = 2500[mV], R1=249000[Ω], R2=1000[Ω]
T: Temperature [degC], V: Sensor output voltage [mV]

For the quality control as post processing, we checked the following sensors, before and after the cruise.

i. Young Rain gauge (SMet and SOAR)
Inspect of the linearity of output value from the rain gauge sensor to change Input value by adding fixed quantity of test water.
ii. Barometer (SMet and SOAR)
Comparison with the portable barometer value, PTB220, VAISALA
iii. Thermometer (air temperature and relative humidity) (SMet and SOAR)
Comparison with the portable thermometer value, HMP41/45, VAISALA
iv. SeaSnake SSST
SeaSnake thermistor probe was calibrated by the bath equipped with SBE-3 plus, Sea-Bird Electronics, Inc.
v. ISAR SSST
ISAR sensor (infrared radiometer) was calibrated by CASOTS bath. Reference temperature of the bath was measured by 4-wire thermistor (AS125, GE Sensing).

(4) Preliminary results

Figure 5.11-1 shows time series of the following parameters;

Wind (SMet)
Air temperature and SST (SOAR and SMet)
Relative humidity (SOAR)
Precipitation (SOAR, rain gauge)
Short/long wave radiation (SOAR)
Pressure (SMet)
Sea surface temperature (SMet)
Significant wave height (SMet)

Figure 5.11-2 shows time series of SSST and SST.

(5) Data archives

These meteorological data will be submitted to the Data Management Group (DMG) of JAMSTEC just after the cruise.

(6) Remarks (Times in UTC)

1) The observation was carried out within following periods,
Leg1: 12:00 25th Sep. 2011 to 00:00 26th Oct. 2011
Leg2: 00:00 29th Oct. 2011 to 03:00 1st Dec. 2011

2) The following periods, SeaSnake SSST data is available.
[T01-005 & T01-100 sensor]
04:53 30th Sep. 2011 to 06:38 24th Oct. 2011
05:09 31st Oct. 2011 to 11:29 13th Nov. 2011
11:35 13th Nov. 2011 to 03:55 14th Nov. 2011
04:46 14th Nov. 2011 to 00:59 15th Nov. 2011
[T03-005 & T03-100 sensor]
01:48 15th Nov. 2011 to 03:55 29th Nov. 2011

3) The following periods, ISAR observation was suspended.
12:00 25th Sep. 2011 to 03:23 26th Sep. 2011
04:03 20th Oct. 2011 to 16:27 20th Oct. 2011

4) The following periods, SOAR wind direction (relative and true) data is not available due to sensor trouble.
05:51 13th Nov. 2011 to 06:33 13th Nov. 2011

Table 5.11-1: Instruments and installation locations of MIRAI Surface Meteorological observation system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Tair/RH	HMP45A	Vaisala, Finland with	
43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21 m) starboard side and port side
Thermometer: SST	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	Model-370	Setra System, USA	captain deck (13 m) weather observation room
Rain gauge	50202	R. M. Young, USA	compass deck (19 m)
Optical rain gauge	ORG-815DR	Osi, USA	compass deck (19 m)
Radiometer (short wave)	MS-802	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10 m)

Table 5.11-2: Parameters of MIRAI Surface Meteorological observation system

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 Ship's speed	knot	Mirai log, DS-30 Furuno
4 Ship's heading	degree	Mirai gyro, TG-6000, Tokimec
5 Relative wind speed	m/s	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 (bow)	m	hourly
22 Significant wave height (aft)	m	hourly
23 Significant wave period (bow)	second	hourly
24 Significant wave period (aft)	second	hourly

Table 5.11-3: Instruments and installation locations of SOAR system

Sensors (Zeno/Met)	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	foremast (25 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield			
		R.M. Young, USA	foremast (23 m)
Barometer	61202V	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	foremast (23 m)
Rain gauge	50202	R.M. Young, USA	foremast (24 m)
Optical rain gauge	ORG-815DA	Osi, USA	foremast (24 m)

Sensors (PRP)	Type	Manufacturer	Location (altitude from surface)
Radiometer (short wave)	PSP	Epply Labs, USA	foremast (25 m)
Radiometer (long wave)	PIR	Epply Labs, USA	foremast (25 m)
Fast rotating shadowband radiometer		Yankee, USA	foremast (25 m)

Sensors (SeaSnake)	Type	Manufacturer	Location (altitude from surface)
Thermistor	107	Campbell Scientific, USA	bow, 5m extension (0 m)

Sensors (ISAR)	Manufacturer	Location (altitude from surface)
ISAR	SOES, UK	foremast (24 m)

Table 5.11-4: Parameters of SOAR system

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 SOG	knot	
4 COG	degree	
5 Relative wind speed	m/s	
6 Relative wind direction	degree	
7 Barometric pressure	hPa	
8 Air temperature	degC	
9 Relative humidity	%	
10 Rain rate (optical rain gauge)	mm/hr	
11 Precipitation (capacitive rain gauge)	mm	reset at 50 mm
12 Down welling shortwave radiation	W/m^2	
13 Down welling infra-red radiation	W/m^2	
14 Defuse irradiance	W/m^2	
15 “SeaSnake” raw data	mV	
16 SSST (SeaSnake)	degC	
17 SSST (ISAR)	degC	

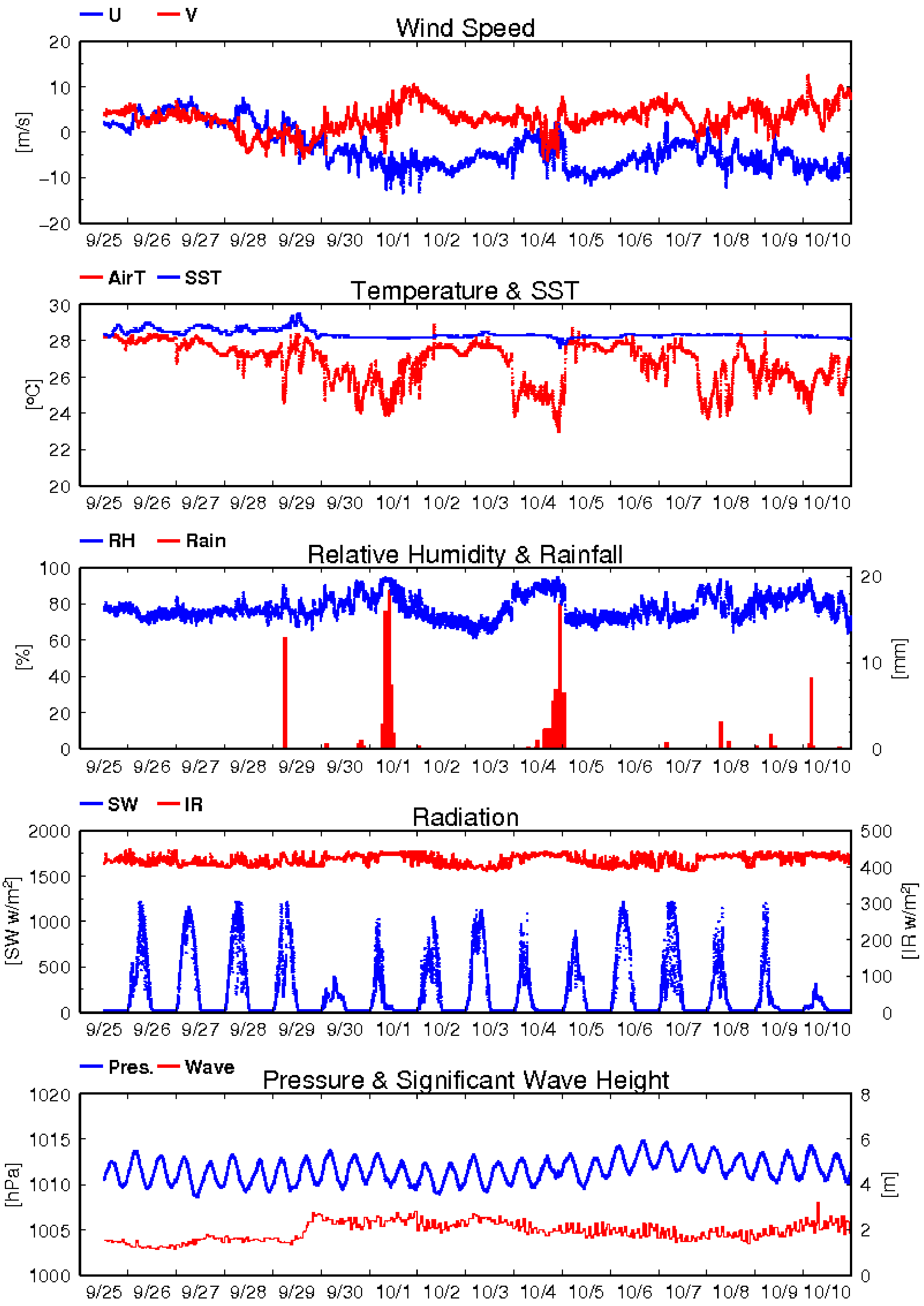


Fig. 5.11-1: Time series of surface meteorological parameters during the cruise.

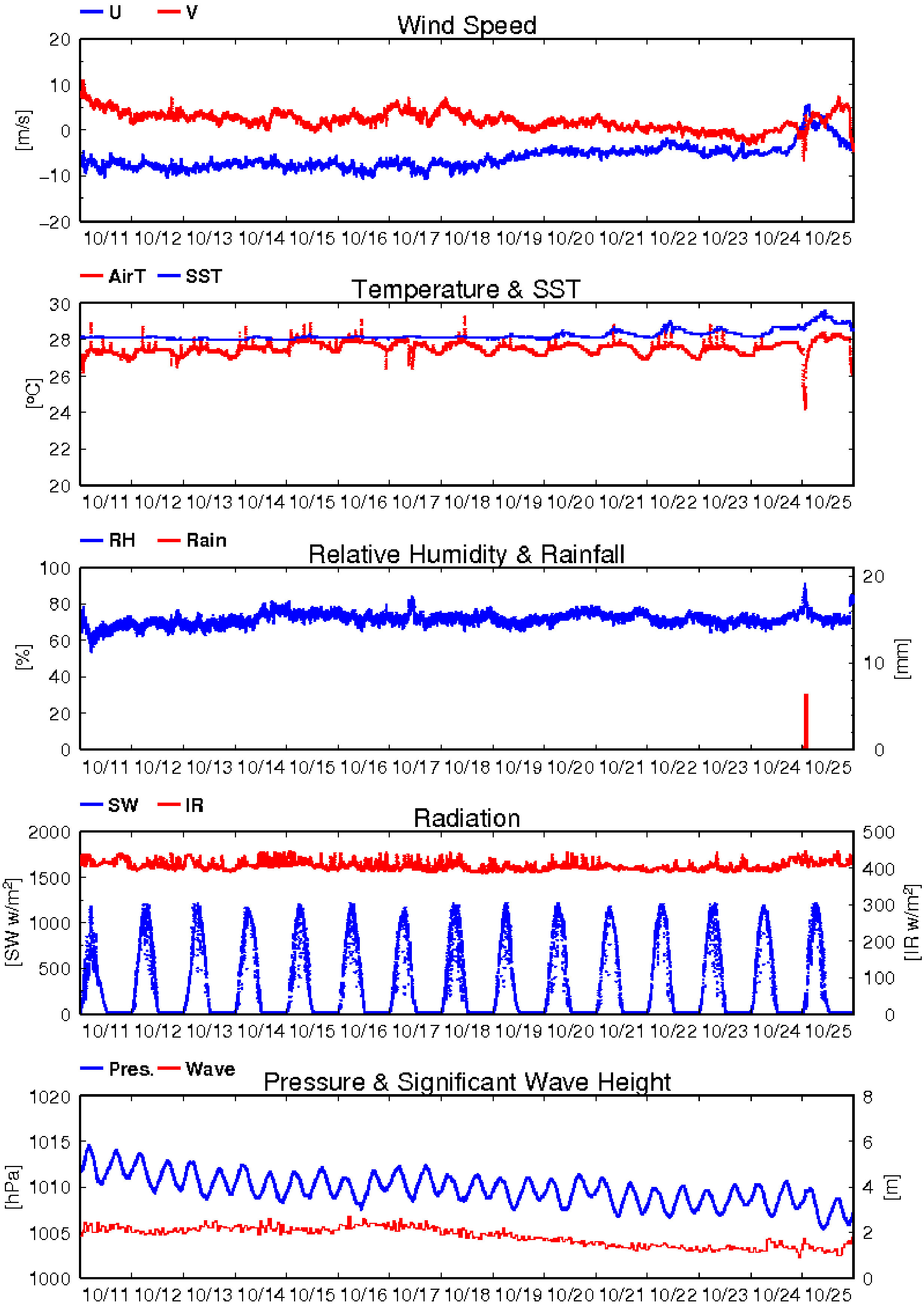


Fig. 5.11-1 (Continued)

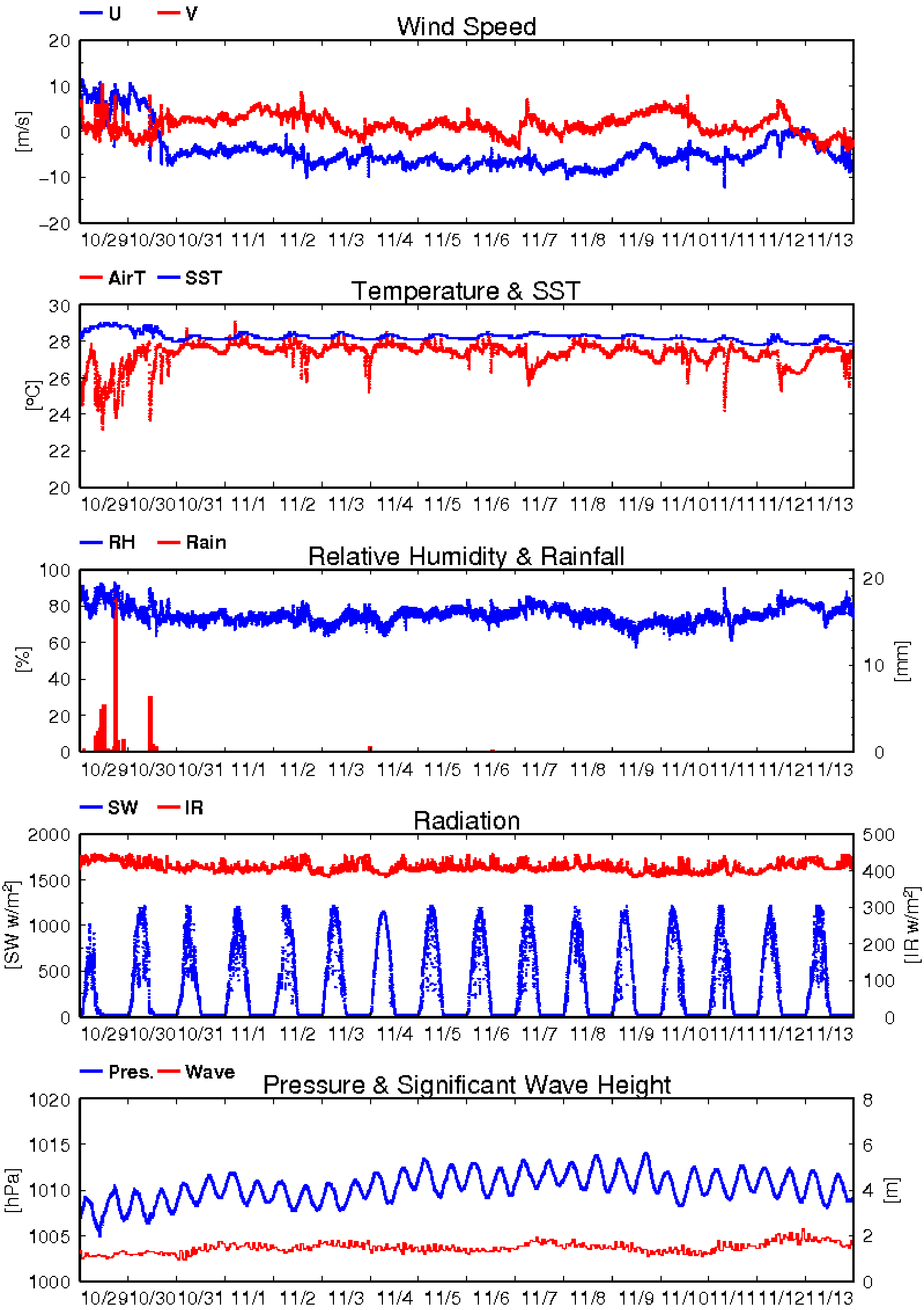


Fig. 5.11-1 (Continued)

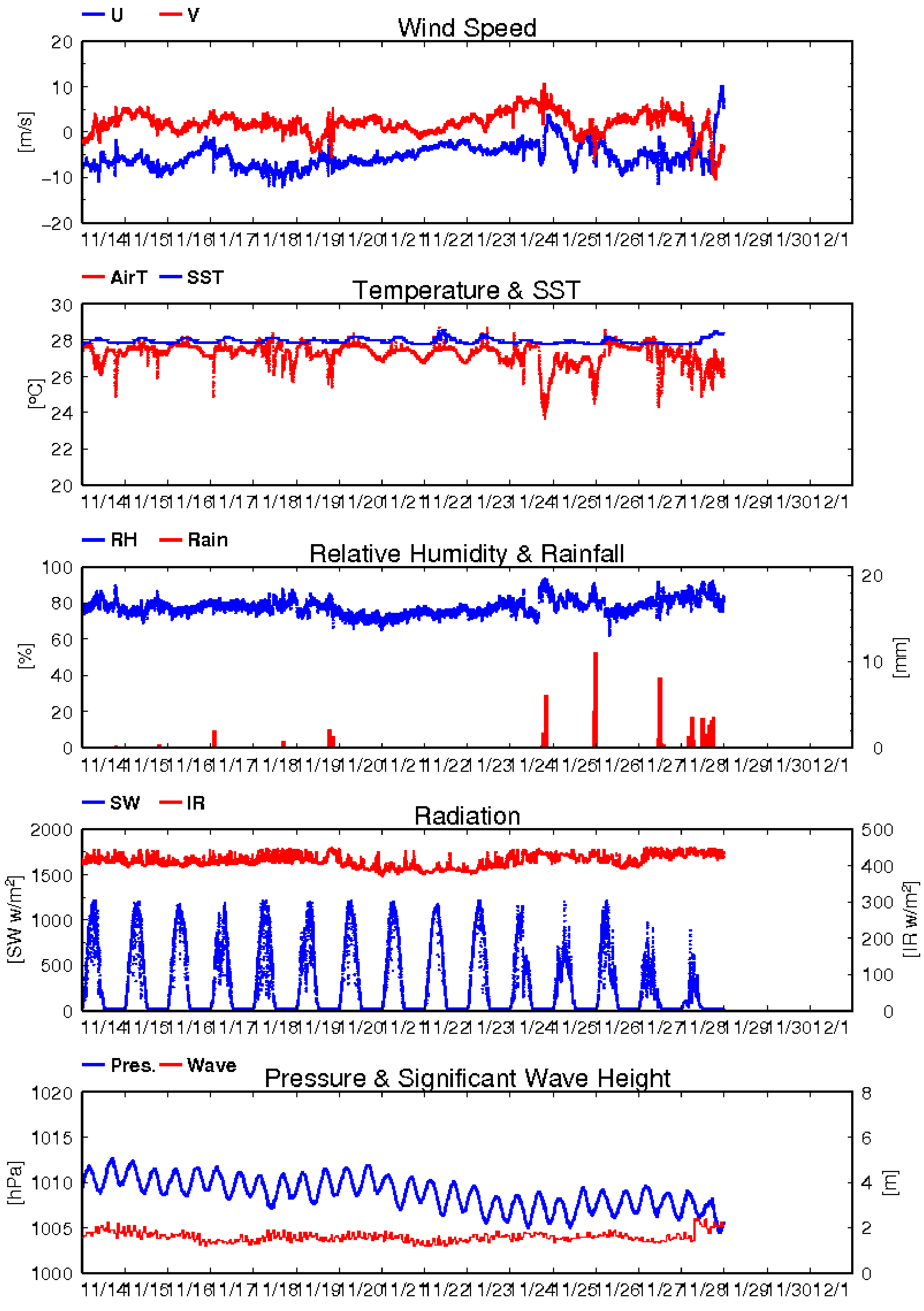


Fig. 5.11-1 (Continued)

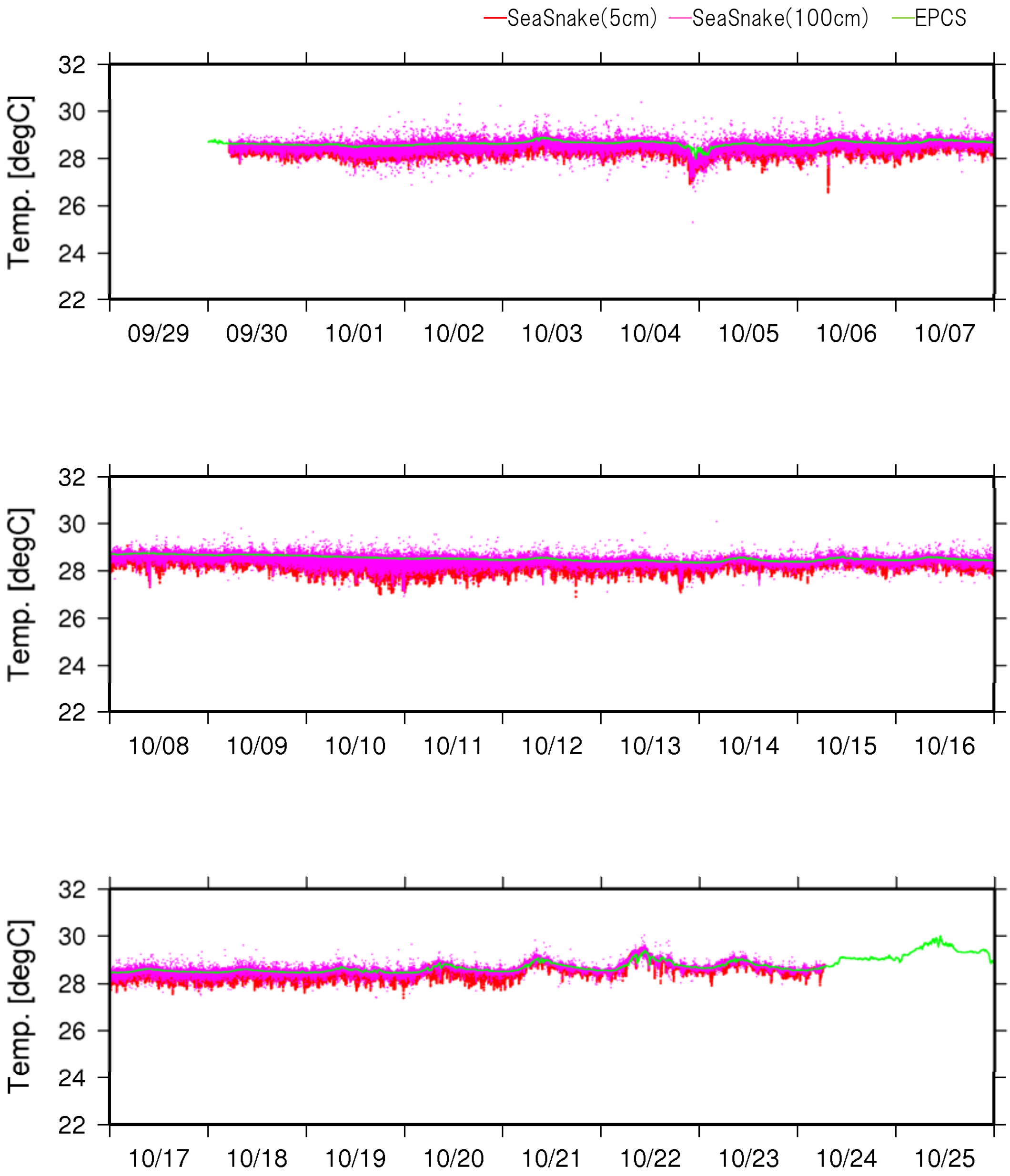


Fig. 5.11-2: Time series of Skin Sea Surface Temperature(SSST, red and purple) and Sea Surface Temperature (EPCS, green) during the cruise.

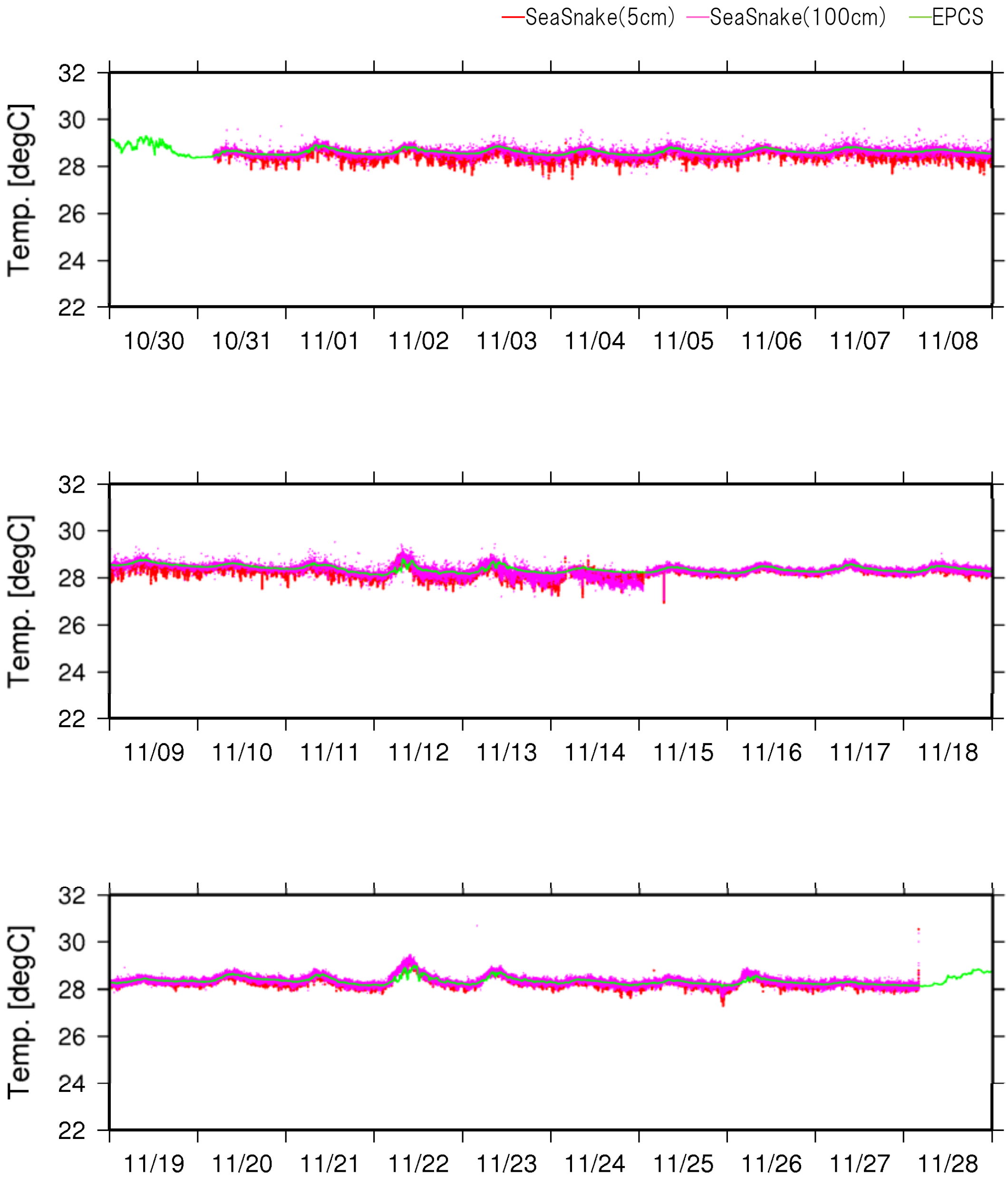


Fig. 5.11-2 (Continued)

5.12 Air-sea surface eddy flux measurement

(1) Personnel

Osamu TSUKAMOTO	(Okayama University)	- Principal Investigator (not on board)
Hirofumi UENO	(Okayama University)	- on-board (Leg-2)
Fumiyoshi KONDO	(University of Tokyo)	- not on board
Hiroshi ISHIDA	(Kobe University)	- not on board

(2) Objective

To better understand the air-sea interaction, accurate measurements of surface heat and fresh water budgets are necessary as well as momentum exchange through the sea surface. In addition, the evaluation of surface flux of carbon dioxide is also indispensable for the study of global warming. Sea surface turbulent fluxes of momentum, sensible heat, latent heat, and carbon dioxide were measured by using the eddy correlation method that is thought to be most accurate and free from assumptions. These surface heat flux data are combined with radiation fluxes and water temperature profiles to derive the surface energy budget.

(3) Instruments and Methods

The surface turbulent flux measurement system (Fig. 1) consists of turbulence instruments (Kaijo Co., Ltd.) and ship motion sensors (Kanto Aircraft Instrument Co., Ltd.). The turbulence sensors include a three-dimensional sonic anemometer-thermometer (Kaijo, DA-600) and an infrared hygrometer (LICOR, LI-7500). The sonic anemometer measures three-dimensional wind components relative to the ship. The ship motion sensors include 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). LI7500 is a CO_2/H_2O turbulence sensor that measures turbulent signals of carbon dioxide and water vapor simultaneously. These signals are sampled at 10 Hz by a PC-based data logging system (Labview, National Instruments Co., Ltd.). By obtaining the ship speed and heading information through the Mirai network system it yields the absolute wind components relative to the ground. Combining wind data with the turbulence data, turbulent fluxes and statistics are calculated in a real-time basis. These data are also saved in digital files every 0.1 second for raw data and every 1 minute for statistic data.

(4) Observation log

The observation was carried out throughout this cruise. Three-hourly ‘flux-cruise’, starting from 00, 03, 06, 09, 12, 15, 18 and 21LST, was applied steaming against the wind to reduce the ship effect during the stationary observation period at (8S,80E) (Leg1; 10:30 30 Sep 24:00 23 Oct, Leg2; 4:30 31 Oct 12:00 28 Nov.).

(5) Data Policy and citation

All data are archived at Okayama University, and will be open to public after quality checks and corrections. Corrected data will be submitted to JAMSTEC Marine-Earth Data and Information Department.

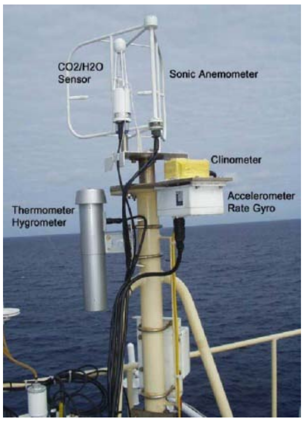


Fig. 5.12-1 Turbulent flux measurement system on the top deck of the foremast

Table 5.12-1 A part of the' flux-cruise' in the daytime are listed here for Leg-2 including human-checked air temperature, relative humidity, SST and weather conditions. All the times are Local Standard Time [UTC+5h]

Run No.	Day	Time(LST)	AT(degC)	RH(%)	SST(degC)	Remarks
1	2011/10/31	6:07	27.3	78	28.1	Cloudy
2		12:23	27.7	75	28.3	Fine
3		15:02	27.7	77	28.3	Cloudy
4		18:06	27.6	74	28.2	Cloudy
5	2011/11/1	6:05	27.6	72	28.1	Fine
6		9:12	27.7	73	28.2	Cloudy
7		12:18	27.8	73	28.3	Fine
8		15:06	27.8	73	28.5	Cloudy
9		18:06	27.5	76	28.4	Fine
10	2011/11/2	6:07	27.4	75	28.1	Cloudy
11		8:56	27.4	78	28.1	Fine
12		12:18	27.6	75	28.4	Fine
13		15:03	27.7	71	28.4	Fine
14		18:08	28	75	28.3	Fine
15	2011/11/3	6:03	27.5	73	28.2	Fine
16		9:03	27.5	71	28.2	Fine
17		12:19	27.7	73	28.4	Fine
18		14:58	27.7	74	28.5	Cloudy
19		18:07	27.5	77	28.3	
20	2011/11/4	6:06	27.2	77	28.1	Fine
21		9:03	27.7	77	28.2	Fine
22		12:21	27.7	70	28.3	Fine
23		14:58	27.7	73	28.4	Fine
24		18:06	27.6	76	28.3	Fine
25	2011/11/5	6:00	27.3	78	28.1	Fine
26		8:59	27.8	76	28.2	Fine
27		12:23	27.4	79	28.3	Fine
28		14:58	27.4	77	28.4	Fine
29		18:05	27.3	75	28.3	Fine
30	2011/11/6	6:43	27.3	80	28.2	Fine
31		8:59	27.5	79	28.2	Fine
32		12:20	27.3	78	28.3	Fine
33		14:55	27.6	74	28.4	Fine
34		18:04	27.5	78	28.3	Fine
35	2011/11/7	6:02	27.5	79	28.2	Fine
36		8:56	27.5	81	28.3	Fine
37		12:19	26.3	81	28.4	Fine
38		14:52	26.4	83	28.5	Fine
39		18:03	26.7	80	28.4	Fine
40	2011/11/8	6:14	27.2	82	28.3	Fine
41		8:58	27.6	79	28.3	Fine
42		12:24	27.7	75	28.3	Fine
43		14:55	27.3	77	28.4	Fine
44		18:03	27.5	78	28.3	Fine
45	2011/11/9	6:05	27.3	71	28.2	Fine
46		8:59	27.6	72	28.2	Fine
47		12:26	27.5	74	28.3	Fine
48		14:52	27.5	68	28.4	Fine
49		18:02	27.2	72	28.3	Fine
50	2011/11/10	6:03	26.8	73	28.1	Fine
51		8:58	27.5	72	28.1	Fine
52	2011/11/11	8:53	27.5	74	28.1	Fine
53		12:21	27.4	73	28.2	Rain
54		14:55	27.2	78	28.2	Fine
55		18:09	27.3	75	28.1	Fine
56	2011/11/12	8:55	27.5	77	27.9	Fine
57		12:26	27.3	77	28.2	Cloudy
58		14:51	27.3	77	28.2	Fine
59		18:00	26.2	80	28	Cloudy
60	2011/11/13	6:04	26.6	83	27.8	Cloudy

Run No.	Day	Time(LST)	AT(degC)	RH(%)	SST(degC)	Remarks
61	2011/11/13	8:54	27.2	81	27.9	Cloudy
62		12:24	27.5	82	28.1	Cloudy
63		14:55	27.7	75	28.3	Fine
64		18:03	27.4	77	28.1	Fine
65	2011/11/14	6:09	27.5	77	27.8	Fine
66		8:54	27.6	81	27.9	Fine
67		12:19	26.3	83	28	Fine
68		14:54	26.5	85	28	Cloudy
69		18:06	27	80	28	Cloudy
70	2011/11/15	6:20	27.3	78	27.9	Fine
71		9:00	27.5	78	27.9	Cloudy
72		12:20	27.4	76	28.1	Fine
73		14:54	27.6	76	28.1	Fine
74		18:09	27.2	79	28	Cloudy
75	2011/11/16	6:17	27.4	76	27.9	Fine
76		8:58	27.6	78	27.9	Fine
77		12:18	27.6	78	28	Fine
78		14:52	27.6	79	28.1	Cloudy
79		18:07	27.4	79	28	Fine
80	2011/11/17	8:52	27.5	80	27.9	Fine
81		12:18	27.4	79	28	Fine
82		14:55	27.3	80	28.2	Fine
83		18:01	27.1	83	28	Fine
84	2011/11/18	6:02	27.3	80	27.9	Fine
85		9:02	27.8	78	27.9	Fine
86		12:20	27.6	80	28.1	Rain
87		14:55	27.7	77	28.1	Fine
88		18:06	27.4	82	28.1	Cloudy
89	2011/11/19	6:03	27.4	75	27.9	Cloudy
90		8:58	27.1	77	27.9	Fine
91		12:26	27.8	75	28	Cloudy
92		14:56	27.1	83	28	Cloudy
93		18:04	26.9	81	28	Fine
94	2011/11/20	8:56	27.6	77	27.9	Fine
95		12:20	27.7	72	28.2	Fine
96		14:51	27.7	73	28.1	Fine
97		18:05	27.4	74	28.1	Fine
98	2011/11/21	6:03	26.8	70	27.9	Fine
99		8:51	27.2	75	27.9	Fine
100		12:19	27.2	73	28.1	Fine
101		18:01	27.3	76	28	Fine
102	2011/11/22	6:04	26.8	77	27.8	Fine
103		8:53	27.1	75	27.9	Fine
104		12:18	27.4	75	28.1	Fine
105		14:52	27.4	75	28.4	Fine
106		18:02	27.3	77	28.2	Fine
107	2011/11/23	6:04	26.8	76	27.8	Fine
108		8:49	27.2	75	27.9	Fine
109		12:19	27.4	76	28.1	Fine
110		14:52	27.6	76	28.2	Fine
111		18:02	27.3	76	28.1	Fine
112	2011/11/24	6:30	26.9	81	27.9	Rain
113		8:59	27.6	76	27.9	Cloudy
114		12:29	25.3	84	28	Cloudy
115		14:52	27.7	75	28	Fine
116		18:08	27.4	77	27.9	Cloudy
117	2011/11/25	9:56	26.5	85	27.9	Cloudy
118		12:26	27	80	28	Cloudy
119		14:55	26.5	84	27.9	Cloudy
120		18:02	26.3	83	27.9	Cloudy

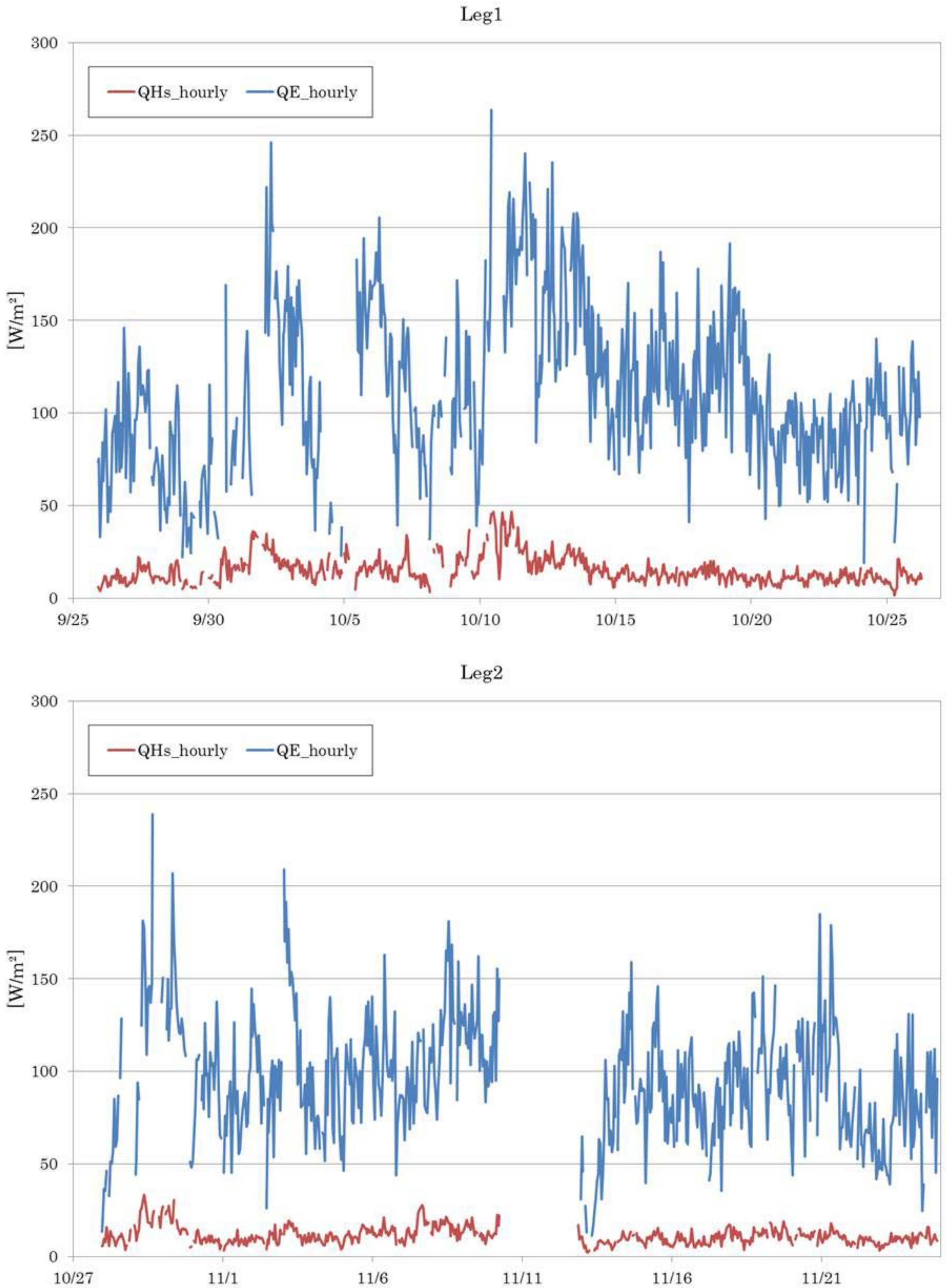


Fig. 5.12-1. Preliminary results of eddy fluxes of sensible heat (QHs), latent heat (QE) calculated with eddy-covariance method. Water vapor corrections were not applied to the sensible heat flux.

5.13 Continuous monitoring of surface seawater

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio YONEYAMA*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki KATSUMATA***	(JAMSTEC)	- Principal Investigator (Leg-2)
Hironori SATO*	(MWJ)	- Operation Leader (Leg-1)
Kanako YOSHIDA*	(MWJ)	
Ayaka HATSUYAMA*	(MWJ)	
Masahiro ORUI *	(MWJ)	
Shinichiro YOKOGAWA**	(MWJ)	- Operation Leader (Leg-2)
Miyo IKEDA**	(MWJ)	

(2) Objective

Our purpose is to obtain salinity, temperature, dissolved oxygen, and fluorescence data continuously in near-sea surface water.

(3) Instruments and Methods

The Continuous Sea Surface Water Monitoring System (Marine Works Japan Co. Ltd.) has four sensors and automatically measures salinity, temperature, dissolved oxygen and fluorescence in near-sea surface water every one minute. This system is located in the "*sea surface monitoring laboratory*" and connected to shipboard LAN-system. Measured data, time, and location of the ship were stored in a data management PC. The near-surface water was continuously pumped up to the laboratory from about 4 m water depth and flowed into the system through a vinyl-chloride pipe. The flow rate of the surface seawater was adjusted to be 4.5 dm^3 min^{-1}. Specifications of the each sensor in this system are listed below.

a. Instruments

Software

Seamoni-kun Ver.1.20

Sensors

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

Temperature and Conductivity sensor

Model: SBE-45, SEA-BIRD ELECTRONICS, INC.
Serial number: 4563325-0362
Measurement range: Temperature -5 to +35 ^{o}C
Conductivity 0 to 7 S m^{-1}
Initial accuracy: Temperature 0.002 ^{o}C
Conductivity 0.0003 S m^{-1}
Typical stability (per month): Temperature 0.0002 ^{o}C
Conductivity 0.0003 S m^{-1}
Resolution: Temperatures 0.0001 ^{o}C
Conductivity 0.00001 S m^{-1}

Bottom of ship thermometer

Model: SBE 38, SEA-BIRD ELECTRONICS, INC.

Serial number: 3857820-0540
Measurement range: -5 to +35 ^{o}C
Initial accuracy: ±0.001 ^{o}C
Typical stability (per 6 month): 0.001 ^{o}C
Resolution: 0.00025 ^{o}C

Dissolved oxygen sensor
Model: OPTODE 3835, AANDERAA Instruments.
Serial number: 1519
Measuring range: 0 - 500 μmol dm^{-3}
Resolution: <1 μmol dm^{-3}
Accuracy: <8 μmol dm^{-3} or 5% whichever is greater
Settling time: <25 s

Fluorometer
Model: C3, TURNER DESIGNS
Serial number: 2300123

(4) Preliminary Result

We took the surface water samples to compare sensor data with bottle data of salinity and dissolved oxygen and fluorescence. Periods of measurement, maintenance, and problems during MR11-07 are listed in Table 5.13-1.

Table 5.13-1 Events list of the surface seawater monitoring during MR11-07

System Date [UTC]	System Time [UTC]	Events	Remarks
2011/09/25	12:00	All the measurements started and data was available.	Leg 1 start.
2011/10/14	16:38-16:41	Fluorescence measurements was stopped for C3 maintenance	
2011/10/26	00:00	All the measurements stopped.	Leg 1 end.
2011/10/29	00:00	All the measurements started and data was available.	Leg 2 start.
2011/12/1	03:00	All the measurements stopped.	Leg 2 end.

The results are shown in Fig.5.13-1~3. All the salinity samples were analyzed by the Guideline 8400B “AUTOSAL”, and dissolve oxygen samples were analyzed by Winkler method, and fluorescence were analyzed by 10-AU.

(5) Data archive

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

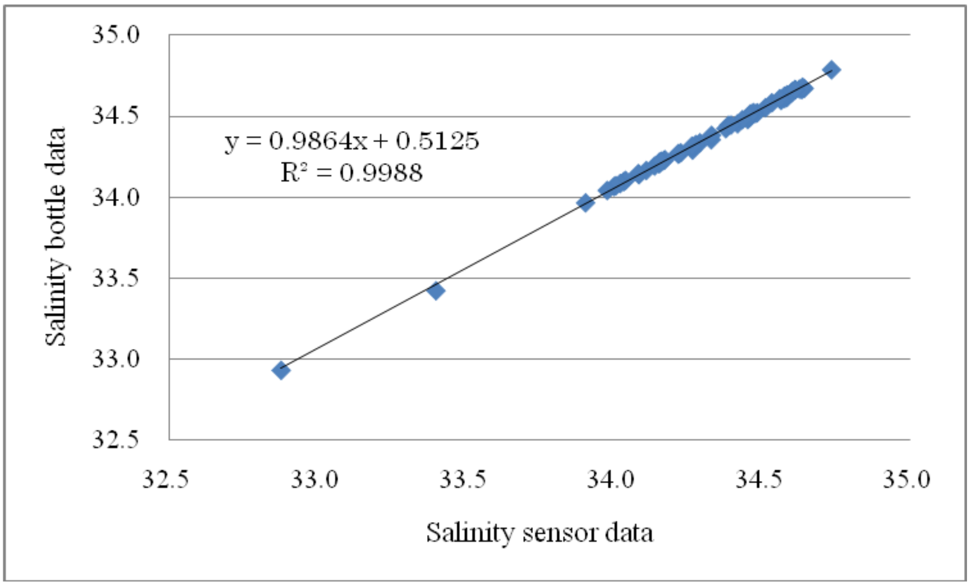


Fig.5.13-1 Correlation of salinity between sensor data and bottle data.

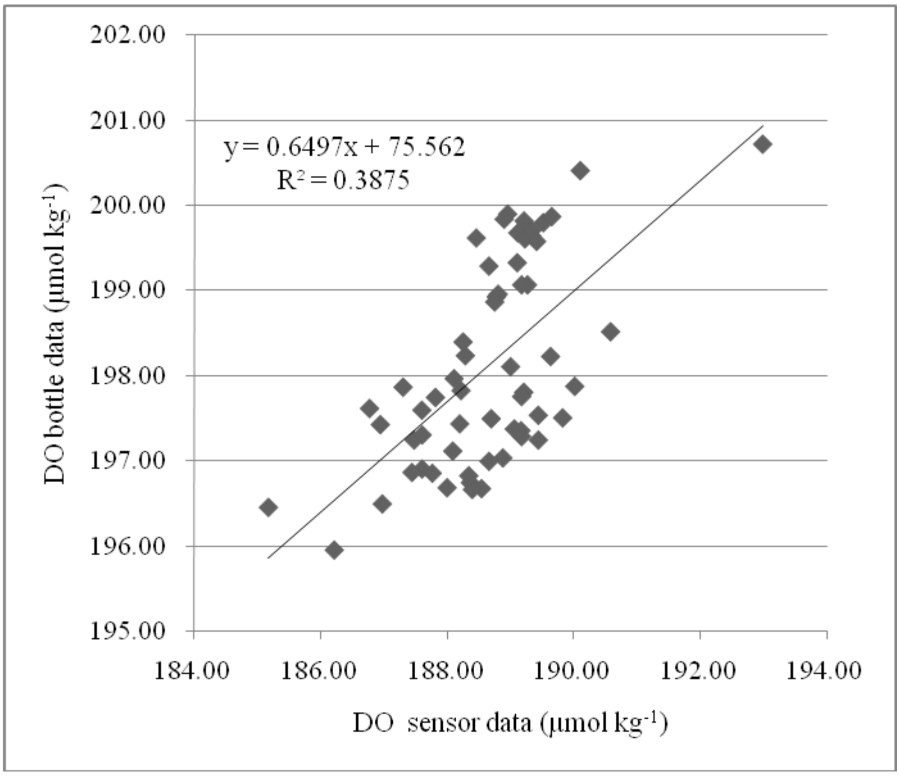


Fig.5.13-2 Correlation of dissolved oxygen between sensor data and bottle data.

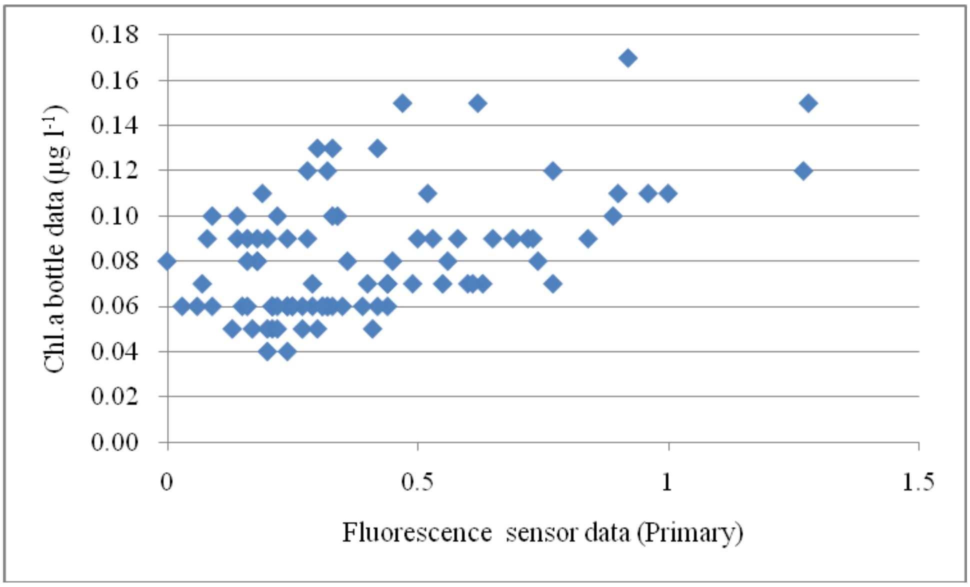


Fig.5.13-3 Correlation of fluorescence between sensor data and bottle data.

5.14 CTDO profiling

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio Yoneyama*	(JAMSTEC)	*Principal Investigator (Leg-1)
Masaki Katsumata ***	(JAMSTEC)	*Principal Investigator (Leg-2)
Naoko Miyamoto*	(MWJ)	*Operation Leader (Leg-1)
Satoshi Ozawa*	(MWJ)	
Fujio Kobayashi*	(MWJ)	
Shinsuke Toyoda*	(MWJ)	
Shungo Oshitani*	(MWJ)	
Yuuki Miyajima*	(MWJ)	
Tatsuya Tanaka**	(MWJ)	*Operation Leader (Leg-2)
Tamami Ueno**	(MWJ)	
Kenichi Katayama**	(MWJ)	
Tomohide Noguchi**	(MWJ)	
Tetsuharu Nishino**	(MWJ)	
Yasumi Yamada**	(MWJ)	

(2) Objective

Investigation of oceanic structure and water sampling.

(3) Parameters

Temperature (Primary and Secondary)
Conductivity (Primary and Secondary)
Pressure
Dissolved Oxygen
Fluorescence

(4) Methods

CTD/Carousel Water Sampling System, which is a 36-position Carousel water sampler (CWS) with Sea-Bird Electronics, Inc. CTD (SBE9plus), was used during this cruise. 12-litter Niskin Bottles (General Oceanics, Inc., Model 1010X NISKIN-X External Spring Niskin Water Sampler), which were washed by neutral detergent, were used for sampling seawater. The sensors attached on the CTD were temperature (Primary and Secondary), conductivity (Primary and Secondary), pressure, dissolved oxygen, and fluorescence. The Practical Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD/CWS was deployed from starboard on working deck.

The CTD raw data were acquired on real time using the Seasave-V7 (ver.7.20g) provided by Sea-Bird Electronics, Inc. and stored on the hard disk of the personal computer. Seawater was sampled during the up cast by sending fire commands from the personal computer. We usually stop at each layer for 30 seconds to stabilize then fire.

423 casts of CTD measurements were conducted (table 5.14-1).

The CTD raw data was processed using SBE Data Processing-Win32 (ver.7.18d) and SEASOFT were as follows:
(The process in order)

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

BOTTLESUM: Create a summary of the bottle data. The data were averaged over 3.0 seconds.

ALIGNCTD: Convert the time-sequence of sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. Dissolved oxygen data are systematically delayed with respect to depth mainly because of the long time constant of the dissolved oxygen sensor and of an additional delay from the transit time of water in the pumped pluming line. This delay was compensated by 6 seconds advancing dissolved oxygen sensor (SBE43) output (dissolved oxygen voltage) relative to the temperature data.

WILDEDIT: Mark extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, depth, temperature, conductivity and dissolved oxygen voltage (SBE43) and descent rate.
*For ‘time bin’ data, WILDEDIT was not processed.

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

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

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

SECTIONU: *This process is original module of SECTION.
Select a time span of data based on scan number in order to reduce a file size. The minimum number was set to be the starting time when the

CTD package was beneath the sea-surface after activation of the pump. The maximum number was set to be the end time when the package came up to the sea-surface.

LOOPEDIT: Mark scans where the CTD was moving less than the minimum velocity of 0.0 m/s (traveling backwards due to ship roll).
*For ‘time bin’ data, LOOPEDIT was not processed.

DERIVE: Compute dissolved oxygen (SBE43).

BINAVG: Two kinds of bin data were created.
Pressure bin : Average the data into 1-dbar bins.
Time bin : Average the data into 1-second bins.

DERIVE: Compute the practical salinity, potential temperature, and sigma-theta.

SPLIT: Separate the data from an input ‘*.cnv’ file into down cast and up cast files.

Configuration file: MR1107A.con

Specifications of the sensors are listed below.
CTD: SBE911plus CTD system
Under water unit:
SBE9plus (S/N 09P27443-0677, Sea-Bird Electronics, Inc.)
Pressure sensor: Digiquartz pressure sensor (S/N 79511)
Calibrated Date: 11 May 2011
Temperature sensors:
Primary: SBE03-04/F (S/N 031524, Sea-Bird Electronics, Inc.)
Calibrated Date: 29 Jul. 2011
Secondary: SBE03-04/F (S/N 031464, Sea-Bird Electronics, Inc.)
Calibrated Date: 02 Mar. 2011
Conductivity sensors:
Primary: SBE04-04/0 (S/N 041206, Sea-Bird Electronics, Inc.)
Calibrated Date: 14 Jun. 2011
Secondary: SBE04C (S/N 042240, Sea-Bird Electronics, Inc.)
Calibrated Date: 08 Jun. 2011
Fluorescence:
Chlorophyll Fluorometer (S/N 3054, Seapoint Sensors, Inc.)
Gain setting: 30X, 0-5 μg/l
Calibrated Date: None
Offset : 0.000

Dissolved Oxygen sensor:
SBE43 (S/N 430330, Sea-Bird Electronics, Inc.)

Calibrated Date: 22 Jul. 2011

Carousel water sampler:

SBE32 (S/N 3221746-0278, Sea-Bird Electronics, Inc.)

Used Cast: from 4SM001 to 8SM242

SBE32 (S/N 3227443-0391, Sea-Bird Electronics, Inc.)

Used Cast: from 8SM243 to 5SM002

Deck unit: SBE11plus(V2) (S/N 11P7030-0272, Sea-Bird Electronics, Inc.)

(5) Preliminary Results

During this cruise, 423 casts of CTD observation (Leg1:195 casts, Leg2:228 casts) were carried out. Date, time and locations of the CTD casts are listed in Table 5.14-1. The time series contours of salinity, temperature, dissolved oxygen and fluorescence are shown in figure 5.14-1. Vertical profiles (down cast) of primary temperature, salinity, dissolved oxygen and fluorescence with pressure are shown in the appendix.

(6) Remarks

In the cast 4SM001, the information of ship position (NMEA) was added in the header file after the cast, because the information was not obtained during the cast. In the cast 8SM130, the data of scan number 66000 was deleted due to the problem of data process. In the cast 8SM203, the data of scan number from 22723 to 23963 was deleted, because the upcast data of about 10m was included during downcast. In the cast 8SM242, water samples of 60m, 40m, 20m and 10m were not collected, due to Carousel Water Sampler trouble. In the cast 8SM334, the fluorescence data at 60m in the CTD bottle data was except for spike and re-processed. In the cast 5SM002, the header information was changed form '8S' to '5S'.

In the cast 8SM009, the Niskin Bottle #20 was not fired correctly at 100m (miss tripped). In the cast 8SM161, the bottom of this cast was changed from 1000m to 500m, because TurboMAP had priority at this cast. In the cast 8SM171, the bottom depth of this cast was changed from 500m to 600m, and the water sampling of 500m was canceled.

Temperature and conductivity sensors of secondary were shifted from downcast 110db to surface in the cast 8SM093, and from down 110db to surface in the cast 8SM095, because something invaded into the TC-duct. DO sensor was noisy from about upcast 220db to 210db in the cast of 8SM115 and 8SM116. DO sensor was drifted from the cast of 8SM117.

(7) Correction of the CTD salinity

The CTD salinity data was corrected by the bottle salinity data obtained at 1000m and measured by AUTOSAL. The bottle salinity data was obtained once a day. The correction coefficient was calculated by “the method of least squares” of the time and the difference between the CTD salinity data and the bottle salinity data of each cast, and the formula of the correction coefficient was as follows:

Offset = CTDSal – BtlSal

CTDSal_cal = CTDSal_raw - Offset

Where ,

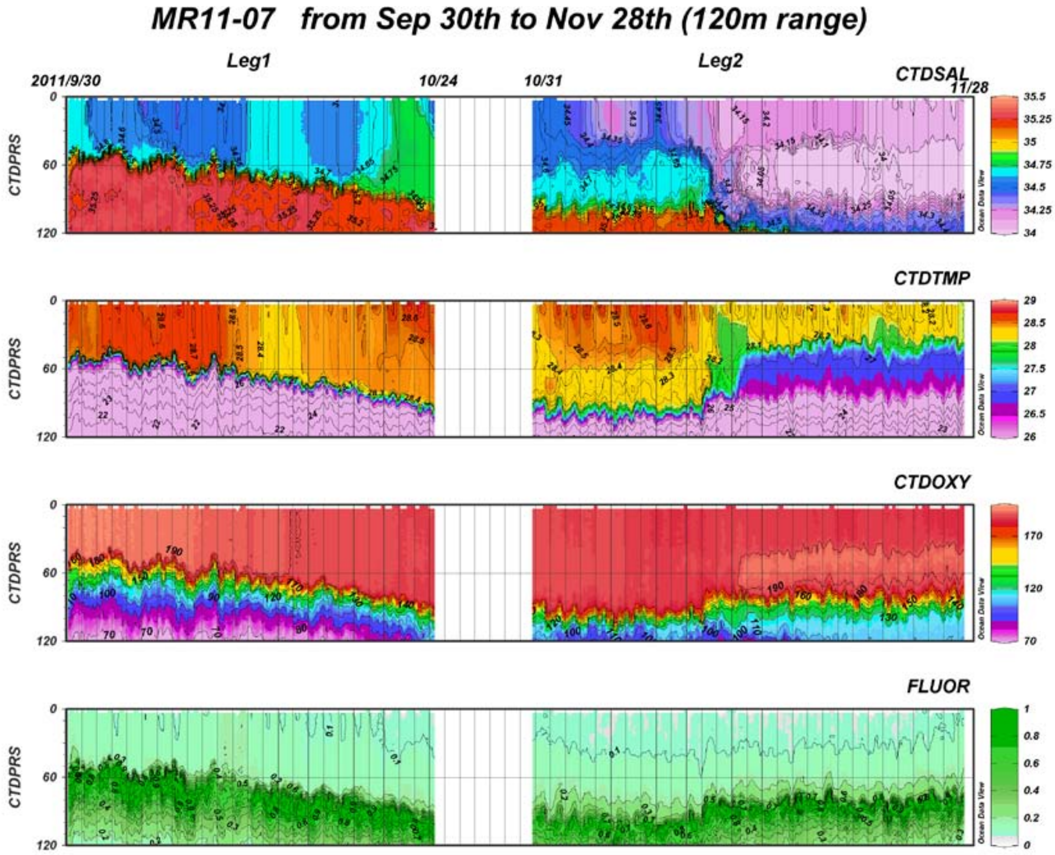
Offset: correction coefficient at each cast

CTDSal : CTD salinity data when fired during upcast
BtlSal : bottle salinity data measured by AUTOSAL
CTDSal_cal : corrected CTD salinity data
CTDSal_raw : noncorrected CTD salinity data

The correction formula was separated between Leg1 and Leg2, because the correction formula was difference between Leg1 and Leg2. In Leg1, Offset of the Primary CTDsal_raw was about -0.004 to -0.005 (psu) and Offset of the secondary CTDsal_raw was from about +0.002 to -0.008 (psu). The results of the corrected salinity data of CTD are summarized in Fig. 5.14-2. In Leg2, Offset of the Primary CTDsal_raw was about -0.004 (psu) and Offset of the secondary CTDsal_raw was from about -0.008 to -0.013 (psu). The results of the corrected salinity data of CTD are summarized in Fig. 5.14-3.

(8) Data archive

All raw and processed data will be submitted to the Data Management Office (DMO), JAMSTEC, and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC home page.



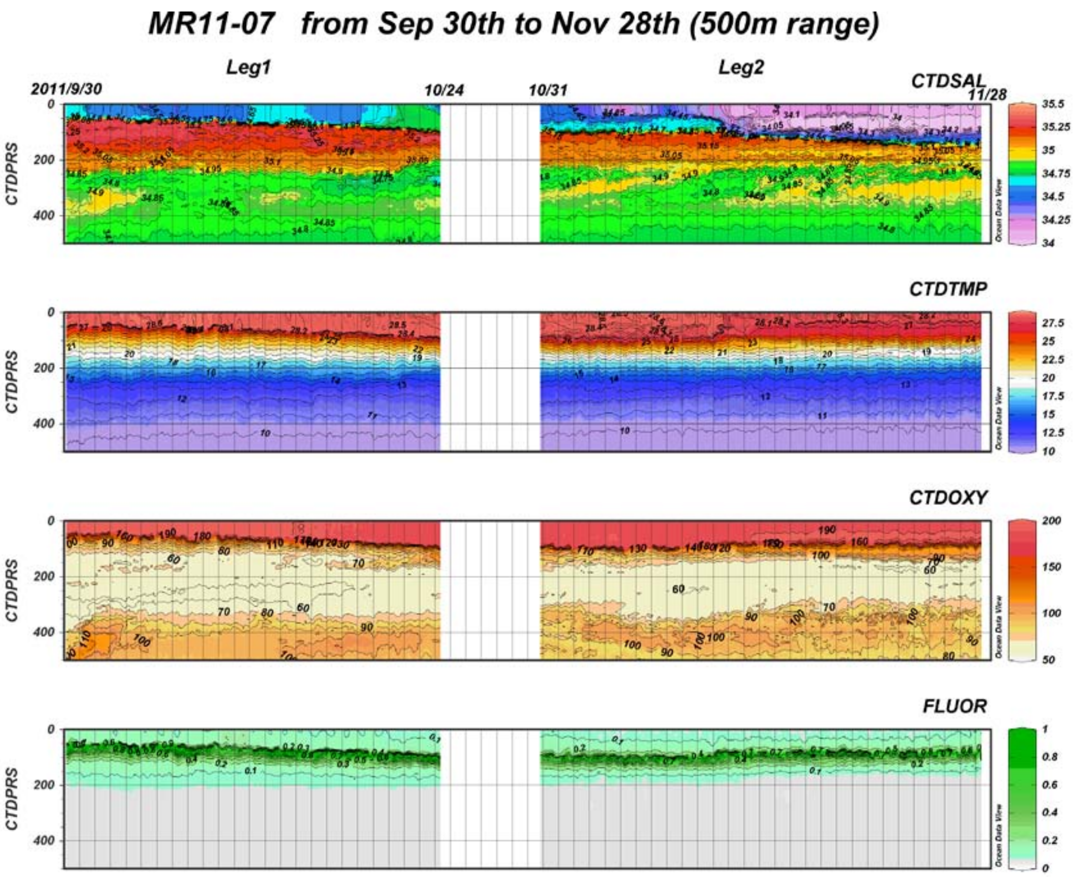


Fig. 5.14-1 the time series contours shows salinity, temperature, dissolved oxygen and fluorescence. Upper shows 120m range and lower shows 500m range, respectively.

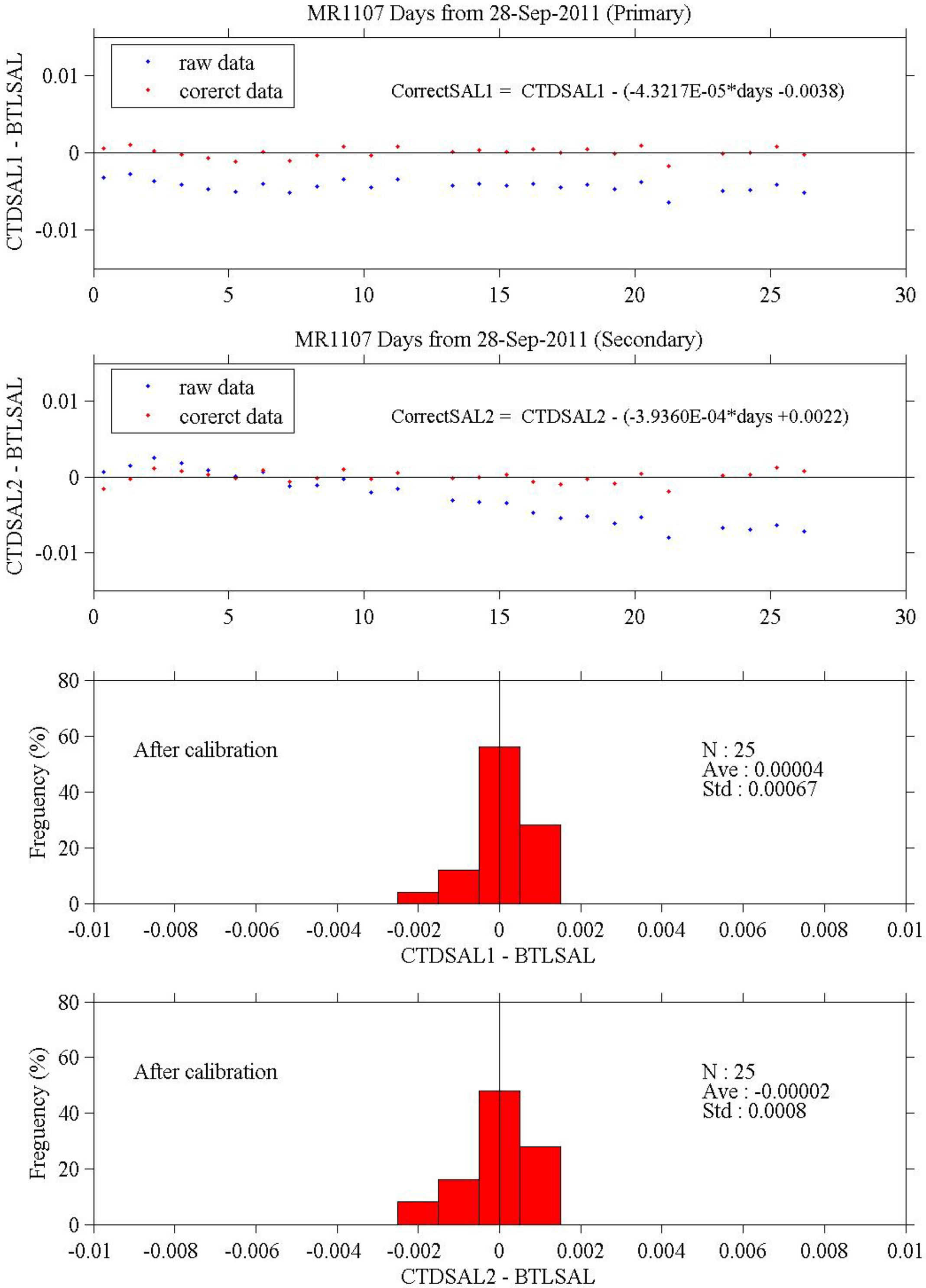


Fig. 5.14-2 the result of CTD salinity correction in Leg1

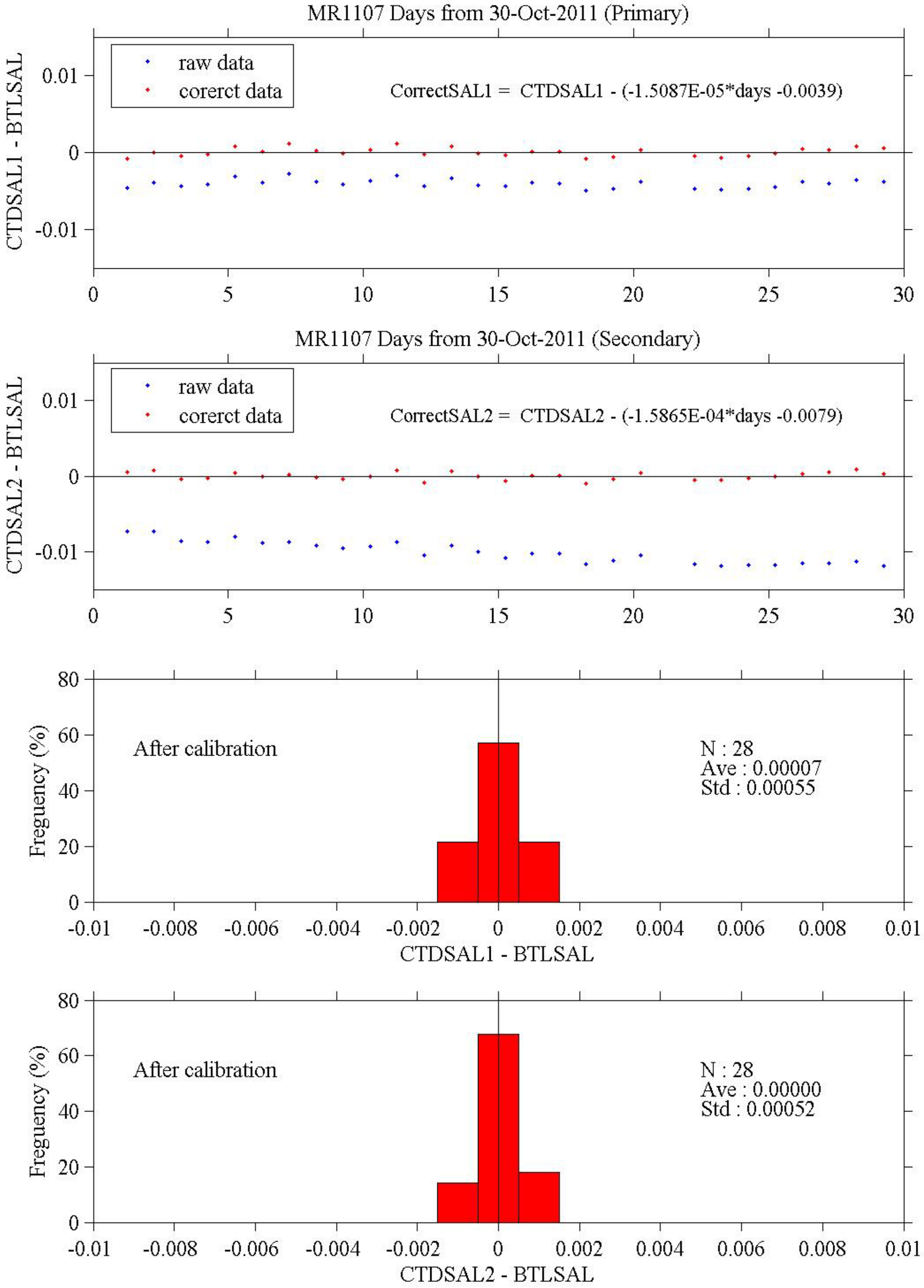


Fig. 5.14-3 the result of CTD salinity correction in Leg2

Table 5.14-1 CTD Cast table

Stnnbr	Castno	Date(UTC) (mmddyy)	Time(UTC) Start	End	BottomPosition Latitude	Longitude	Depth	Wire Out	Max Depth	Max Pressure	CTD Filename	COR Filename	Sampling	Remark
4S	1	092811	08:39	09:24	03-59.85S	080-29.72E	5028.0	998.1	1000.1	1009.6	4SM001	-	Sal, pH	Start of Leg1 The information of ship position (NMEA) was added in the header file, because the information was not collected during this cast.
5S	1	092911	08:04	08:50	05-06.64S	078-06.54E	4980.0	999.6	1000.4	1008.6	5SM001	-	Sal, pH, Pig	
8S	1	093011	05:40	06:35	07-59.40S	080-30.56E	5391.0	1000.9	1001.9	1008.0	8SM001	2011093006	DO,Sal,pH,Nuts,Pig	
8S	2	093011	08:37	08:55	08-00.04S	080-29.93E	5383.0	497.0	501.0	503.6	8SM002	2011093009	-	
8S	3	093011	11:38	12:12	08-00.08S	080-29.71E	5380.0	498.7	502.4	505.3	8SM003	2011093012	DO,pH,Nuts,Pig	
8S	4	093011	14:37	14:55	07-59.90S	080-29.74E	5382.0	497.4	501.2	504.1	8SM004	2011093015	-	
8S	5	093011	17:38	18:14	07-59.93S	080-29.74E	5381.0	496.8	500.3	502.6	8SM005	2011093018	DO,pH,Nuts,Pig	
8S	6	093011	20:36	20:54	08-00.01S	080-29.83E	5384.0	498.9	502.4	505.8	8SM006	2011093021	-	
8S	7	093011	23:39	00:14	07-59.88S	080-29.74E	5383.0	496.1	499.9	503.1	8SM007	2011100100	DO,pH,Nuts,Pig	
8S	8	100111	02:39	02:57	08-00.03S	080-29.78E	5382.0	499.4	501.2	505.3	8SM008	2011100103	-	
8S	9	100111	05:41	06:32	07-59.89S	080-29.89E	5383.0	1000.0	1001.3	1008.2	8SM009	2011100106	DO,Sal,pH,Nuts,Pig	Bottle #20 (100m) was miss tripped
8S	10	100111	08:41	08:59	08-00.12S	080-29.74E	5382.0	495.7	501.6	504.0	8SM010	2011100109	-	
8S	11	100111	11:48	12:24	07-59.89S	080-29.19E	5380.0	500.0	502.7	504.8	8SM011	2011100112	DO,pH,Nuts,Pig	
8S	12	100111	14:45	15:03	08-00.06S	080-29.27E	5381.0	495.9	501.4	504.8	8SM012	2011100115	-	
8S	13	100111	17:45	18:20	07-59.99S	080-29.07E	5382.0	496.1	501.2	504.6	8SM013	2011100118	DO,pH,Nuts,Pig	
8S	14	100111	20:43	21:01	07-59.95S	080-29.63E	5381.0	497.0	501.0	504.3	8SM014	2011100121	-	
8S	15	100111	23:43	00:17	07-59.79S	080-29.77E	5382.0	499.6	500.7	504.1	8SM015	2011100200	DO,pH,Nuts,Pig	
8S	16	100211	02:45	03:06	07-59.64S	080-30.19E	5387.0	499.0	501.8	505.0	8SM016	2011100203	-	
8S	17	100211	05:40	06:28	08-00.12S	080-30.25E	5382.0	998.9	1001.7	1010.0	8SM017	2011100206	DO,Sal,pH,Nuts,Pig	
8S	18	100211	08:43	09:04	08-00.04S	080-29.68E	5383.0	497.8	502.3	504.6	8SM018	2011100209	-	
8S	19	100211	11:43	12:16	08-00.13S	080-29.48E	5381.0	498.3	500.1	503.6	8SM019	2011100212	DO,pH,Nuts,Pig	
8S	20	100211	14:44	15:04	08-00.06S	080-29.41E	5381.0	496.8	501.2	504.3	8SM020	2011100215	-	
8S	21	100211	17:44	18:19	07-59.96S	080-29.74E	5383.0	496.6	500.4	501.6	8SM021	2011100218	DO,pH,Nuts,Pig	
8S	22	100211	20:41	21:03	08-00.28S	080-29.76E	5382.0	499.8	503.5	507.2	8SM022	2011100221	-	
8S	23	100211	23:42	00:20	08-00.01S	080-29.99E	5385.0	498.1	501.0	503.5	8SM023	2011100300	DO,pH,Nuts,Pig	
8S	24	100311	02:42	03:03	08-00.08S	080-30.54E	5383.0	496.1	500.5	503.9	8SM024	2011100303	-	
8S	25	100311	05:40	06:31	08-00.19S	080-30.58E	5382.0	999.8	1001.4	1008.7	8SM025	2011100306	DO,Sal,pH,Nuts,Pig	
8S	26	100311	08:40	09:01	08-00.21S	080-30.44E	5383.0	498.3	500.4	501.4	8SM026	2011100309	-	
8S	27	100311	11:42	12:19	08-00.10S	080-29.97E	5383.0	496.1	501.4	505.3	8SM027	2011100312	DO,pH,Nuts,Pig	
8S	28	100311	14:43	15:04	07-59.37S	080-29.38E	5383.0	497.0	500.3	505.0	8SM028	2011100315	-	
8S	29	100311	17:42	18:17	07-59.81S	080-30.11E	5382.0	498.3	501.2	504.5	8SM029	2011100318	DO,pH,Nuts,Pig	
8S	30	100311	20:40	21:03	08-00.16S	080-30.57E	5384.0	501.2	501.9	505.7	8SM030	2011100321	-	
8S	31	100311	23:41	00:18	07-59.98S	080-29.98E	5382.0	498.9	501.4	504.8	8SM031	2011100400	DO,pH,Nuts,Pig	
8S	32	100411	02:42	03:02	08-00.19S	080-30.05E	5381.0	498.1	500.1	503.9	8SM032	2011100403	-	
8S	33	100411	05:41	06:33	08-00.38S	080-30.29E	5380.0	1000.1	1001.0	1006.9	8SM033	2011100406	DO,Sal,pH,Nuts,Pig	
8S	34	100411	08:42	09:03	08-00.14S	080-30.09E	5382.0	497.8	501.8	505.9	8SM034	2011100409	-	
8S	35	100411	11:41	12:14	07-59.92S	080-29.81E	5383.0	498.9	500.7	501.6	8SM035	2011100412	DO,pH,Nuts,Pig	
8S	36	100411	14:42	15:01	07-58.98S	080-29.39E	5386.0	496.8	500.0	502.3	8SM036	2011100415	-	
8S	37	100411	17:42	18:16	07-59.86S	080-29.76E	5383.0	495.4	500.4	503.2	8SM037	2011100418	DO,pH,Nuts,Pig	
8S	38	100411	20:41	21:02	07-59.78S	080-29.93E	5384.0	497.9	500.5	504.1	8SM038	2011100421	-	
8S	39	100411	23:39	00:17	07-59.93S	080-30.07E	5383.0	500.5	502.1	505.5	8SM039	2011100500	DO,pH,Nuts,Pig	
8S	40	100511	02:42	03:02	07-59.91S	080-29.98E	5383.0	496.1	500.3	503.7	8SM040	2011100503	-	
8S	41	100511	05:40	06:32	08-00.20S	080-30.02E	5382.0	993.2	1000.5	1008.1	8SM041	2011100506	DO,Sal,pH,Nuts,Pig	
8S	42	100511	08:40	09:01	08-00.06S	080-29.85E	5382.0	496.5	501.2	504.6	8SM042	2011100509	-	
8S	43	100511	11:41	12:15	08-00.10S	080-29.15E	5382.0	499.0	500.6	504.4	8SM043	2011100512	DO,pH,Nuts,Pig	
8S	44	100511	14:43	15:03	08-00.23S	080-29.57E	5381.0	496.6	500.7	503.3	8SM044	2011100515	-	
8S	45	100511	17:42	18:14	08-00.08S	080-29.57E	5381.0	499.6	501.2	505.1	8SM045	2011100518	DO,pH,Nuts,Pig	
8S	46	100511	20:40	21:01	08-00.26S	080-29.67E	5388.0	497.9	502.1	505.6	8SM046	2011100521	-	
8S	47	100511	23:41	00:18	07-59.89S	080-29.85E	5384.0	498.1	501.5	504.8	8SM047	2011100600	DO,pH,Nuts,Pig	
8S	48	100611	02:41	03:01	08-00.17S	080-29.96E	5383.0	495.7	500.8	503.9	8SM048	2011100603	-	
8S	49	100611	05:41	06:35	08-00.30S	080-30.10E	5381.0	998.9	1001.6	1008.3	8SM049	2011100606	DO,Sal,pH,Nuts,Pig	
8S	50	100611	08:41	09:01	08-00.41S	080-29.96E	5381.0	495.9	501.2	504.5	8SM050	2011100609	-	
8S	51	100611	11:40	12:13	07-59.94S	080-29.97E	5384.0	499.2	502.6	506.0	8SM051	2011100612	DO,pH,Nuts,Pig	
8S	52	100611	14:42	15:02	07-59.24S	080-28.95E	5383.0	495.9	500.3	503.0	8SM052	2011100615	-	
8S	53	100611	17:42	18:14	08-00.14S	080-29.82E	5383.0	497.9	500.6	505.0	8SM053	2011100618	DO,pH,Nuts,Pig	
8S	54	100611	20:42	21:03	08-00.24S	080-29.86E	5380.0	498.3	502.5	506.1	8SM054	2011100621	-	
8S	55	100611	23:41	00:16	07-59.95S	080-30.23E	5384.0	497.4	500.7	504.0	8SM055	2011100700	DO,pH,Nuts,Pig	
8S	56	100711	02:41	03:02	08-00.06S	080-30.21E	5384.0	498.3	501.9	505.3	8SM056	2011100703	-	
8S	57	100711	05:41	06:31	08-00.29S	080-30.01E	5382.0	1000.5	1001.9	1009.2	8SM057	2011100706	DO,Sal,pH,Nuts,Pig	
8S	58	100711	08:41	09:02	08-00.28S	080-29.98E	5382.0	497.6	502.2	506.7	8SM058	2011100709	-	
8S	59	100711	11:40	12:14	08-00.08S	080-29.99E	5382.0	500.0	502.5	505.3	8SM059	2011100712	DO,pH,Nuts,Pig	
8S	60	100711	14:41	15:01	07-58.99S	080-29.27E	5382.0	499.0	500.6	504.3	8SM060	2011100715	-	
8S	61	100711	17:41	18:13	07-59.79S	080-30.05E	5386.0	500.7	501.9	505.0	8SM061	2011100718	DO,pH,Nuts,Pig	
8S	62	100711	20:32	20:53	08-00.00S	080-30.18E	5383.0	497.4	500.4	503.8	8SM062	2011100721	-	
8S	63	100711	23:42	00:17	07-59.91S	080-30.14E	5383.0	499.2	500.8	504.1	8SM063	2011100800	DO,pH,Nuts,Pig	
8S	64	100811	02:39	03:00	08-00.16S	080-30.19E	5383.0	500.0	501.3	504.8	8SM064	2011100803	-	
8S	65	100811	05:42	06:32	07-59.96S	080-30.14E	5383.0	1001.6	1002.4	1011.3	8SM065	2011100806	DO,Sal,pH,Nuts,Pig	
8S	66	100811	08:41	09:01	08-00.03S	080-29.80E	5384.0	496.5	501.9	504.3	8SM066	2011100809	-	
8S	67	100811	11:40	12:12	07-59.95S	080-29.89E	5387.0	499.4	503.3	506.8	8SM067	2011100812	DO,pH,Nuts,Pig	
8S	68	100811	14:40	15:00	07-59.98S	080-29.98E	5384.0	497.8	500.8	504.1	8SM068	2011100815	-	
8S	69	100811	17:46	18:18	07-59.96S	080-29.84E	5384.0	498.3	501.8	505.9	8SM069	2011100818	DO,pH,Nuts,Pig	
8S	70	100811	20:41	21:01	07-59.94S	080-29.87E	5382.0	499.6	501.6	505.1	8SM070	2011100821	-	
8S	71	100811	23:40	00:15	07-59.98S	080-29.93E	5384.0	500.5	503.5	507.0	8SM071	2011100900	DO,pH,Nuts,Pig	
8S	72	100911	02:40	03:01	08-00.02S	080-30.06E	5382.0	496.3	501.2	504.7	8SM072	2011100903	-	
8S	73	100911	05:41	06:31	08-00.21S	080-29.52E	5380.0	1001.1	1002.1	1009.7	8SM073	2011100906	DO,Sal,pH,Nuts,Pig	
8S	74	100911	08:40	09:01	08-00.20S	080-29.67E	5384.0	495.7	501.1	504.3	8SM074	2011100909	-	
8S	75	100911	11:40	12:13	08-00.10S	080-29.88E	5383.0	498.7	501.9	504.5	8SM075	2011100912	DO,pH,Nuts,Pig	
8S	76	100911	14:41	15:01	07-59.19S	080-28.85E	5378.0	497.8	501.0	504.3	8SM076	2011100915	-	
8S	77	100911	17:40	18:12	08-00.03S	080-29.77E	5388.0	496.8	500.5	503.1	8SM077	2011100918	DO,pH,Nuts,Pig	
8S	78	100911	20:47	21:08	08-00.08S	080-29.66E	5382.0	496.1	500.4	503.8	8SM078	2011100921	-	
8S	79	100911	23:41	00:16	07-59.81S	080-29.93E	5384.0	496.5	500.0	503.7	8SM079	2011101000	DO,pH,Nuts,Pig	
8S	80	101011	02:54	03:16	07-59.92S	080-29.30E	5383.0	497.6	500.7	504.0	8SM080	2011101003	-	
8S	81	101011	05:50	06:39	08-00.27S	080-29.75E	5380.0	997.2	1000.2	1009.3	8SM081	2011101006	DO,Sal,pH,Nuts,Pig	
8S	82	101011	08:41	09:02	08-00.05S	080-30.15E	5385.0	497.6	502.6	506.5	8SM082	2011101009	-	
8S	83	101011	11:40	12:14	08-00.15S	080-29.81E	5384.0	496.3	501.0	504.6	8SM083	2011101012	DO,pH,Nuts,Pig	
8S	84	101011	14:42	15:02	07-59.27S	080-28.70E	5383.0	496.3	500.3	503.5	8SM084	2011101015	-	
8S	85	101011	17:42	18:15	07-59.93S	080-29.83E	5385.0	497.8	501.3	504.6	8SM085	2011101018	DO,pH,Nuts,Pig	
8S	86	101011	20:42	21:03	08-00.18S	080-29.98E	5383.0	497.4	501.1	504.2	8SM086	2011101021	-	
8S	87	101011	23:42	00:17	08-00.07S	080-29.91E	5383.0	498.3	502.2	505.6	8SM087	2011101100	DO,pH,Nuts,Pig	
8S	88	101111	02:44	03:05	07-59.96S	080-30.21E	5383.0	498.7	500.9	504.5	8SM088	2011101103	-	

Table 5.14-1 CTD Cast table

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire Out	Max Depth	Max Pressure	CTD Filename	COR Filename	Sampling	Remark
		(mmddyy)	Start	End	Latitude	Longitude								
8S	89	101111	05:41	06:31	08-00.03S	080-30.09E	5384.0	997.4	1000.8	1007.7	8SM089	2011101106	DO,Sal,pH,Nuts,Pig	
8S	90	101111	08:42	09:03	08-00.15S	080-30.27E	5384.0	495.7	501.4	505.5	8SM090	2011101109	-	
8S	91	101111	11:41	12:16	08-00.01S	080-29.69E	5385.0	498.3	502.2	503.1	8SM091	2011101112	DO,pH,Nuts,Pig	
8S	92	101111	14:41	15:03	07-59.66S	080-29.17E	5381.0	496.6	501.3	504.9	8SM092	2011101115	-	
8S	93	101111	17:40	18:15	07-59.89S	080-29.85E	5385.0	499.4	502.8	505.7	8SM093	2011101118	DO,pH,Nuts,Pig	Secondary sensor was shifted from downcast 110db to surface, because something invaded into the TC-duct.
8S	94	101111	20:40	21:01	08-00.02S	080-29.94E	5384.0	497.8	501.2	504.7	8SM094	2011101121	-	
8S	95	101111	23:43	00:20	08-00.09S	080-29.78E	5381.0	497.6	500.5	503.9	8SM095	2011101200	DO,pH,Nuts,Pig	Secondary sensor was shifted from downcast 60db to surface, because something invaded into the TC-duct.
8S	96	101211	02:42	03:04	07-59.99S	080-29.96E	5382.0	497.4	501.1	504.5	8SM096	2011101203	-	
8S	97	101211	05:40	06:29	08-00.03S	080-29.92E	5384.0	998.5	1001.2	1008.7	8SM097	2011101206	DO,Sal,pH,Nuts,Pig	
8S	98	101211	08:41	09:02	08-00.07S	080-30.16E	5383.0	493.9	502.1	503.7	8SM098	2011101209	-	
8S	99	101211	11:40	12:15	08-00.13S	080-29.83E	5382.0	497.8	501.1	502.8	8SM099	2011101212	DO,pH,Nuts,Pig	
8S	100	101211	14:41	15:02	07-58.82S	080-29.25E	5358.0	496.1	500.2	503.3	8SM100	2011101215	-	
8S	101	101211	17:41	18:14	08-00.02S	080-29.79E	5383.0	497.6	501.9	504.8	8SM101	2011101218	DO,pH,Nuts,Pig	
8S	102	101211	20:40	21:01	08-00.02S	080-29.98E	5384.0	498.9	502.1	505.4	8SM102	2011101221	-	
8S	103	101211	23:42	00:21	08-00.00S	080-29.99E	5382.0	498.5	500.8	504.5	8SM103	2011101300	DO,pH,Nuts,Pig	
8S	104	101311	02:41	03:03	07-59.91S	080-30.02E	5384.0	494.6	500.1	503.0	8SM104	2011101303	-	
8S	105	101311	05:41	06:30	08-00.03S	080-29.71E	5384.0	999.2	100.4	1007.9	8SM105	2011101306	DO,Sal,pH,Nuts,Pig	
8S	106	101311	08:41	09:01	07-59.93S	080-29.80E	5385.0	495.4	502.5	505.2	8SM106	2011101309	-	
8S	107	101311	11:52	12:27	08-00.13S	080-29.83E	5383.0	495.7	500.2	502.7	8SM107	2011101312	DO,pH,Nuts,Pig	
8S	108	101311	14:41	15:02	07-59.54S	080-28.62E	5388.0	495.9	501.1	505.0	8SM108	2011101315	-	
8S	109	101311	17:42	18:15	08-00.05S	080-29.94E	5383.0	500.3	504.4	508.6	8SM109	2011101318	DO,pH,Nuts,Pig	
8S	110	101311	20:40	21:00	08-00.07S	080-29.92E	5384.0	497.9	500.2	503.7	8SM110	2011101321	-	
8S	111	101311	23:41	00:18	08-00.06S	080-30.05E	5382.0	499.6	501.0	505.0	8SM111	2011101400	DO,pH,Nuts,Pig	
8S	112	101411	02:42	03:03	08-00.24S	080-29.73E	5379.0	497.6	500.3	503.7	8SM112	2011101403	-	
8S	113	101411	05:40	06:30	08-00.18S	080-29.84E	5382.0	997.6	1001.9	1008.4	8SM113	2011101406	DO,Sal,pH,Nuts,Pig	
8S	114	101411	08:40	09:01	08-00.04S	080-30.18E	5384.0	495.9	500.3	504.5	8SM114	2011101409	-	
8S	115	101411	11:40	12:15	08-00.37S	080-30.14E	5381.0	499.4	502.9	506.9	8SM115	2011101412	DO,pH,Nuts,Pig	DO sensor was noisy from upcast 217db to 208db.
8S	116	101411	14:41	15:02	08-00.09S	080-30.01E	5382.0	499.0	502.6	506.3	8SM116	2011101415	-	DO sensor was noisy from upcast 221db to 208db.
8S	117	101411	17:40	18:13	08-00.19S	080-29.87E	5382.0	496.8	501.2	504.9	8SM117	2011101418	DO,pH,Nuts,Pig	DO sensor was drifted from this cast.
8S	118	101411	20:40	21:01	07-59.97S	080-30.08E	5385.0	495.4	501.1	504.4	8SM118	2011101421	-	
8S	119	101411	23:43	00:20	08-00.01S	080-29.98E	5384.0	499.0	502.3	505.7	8SM119	2011101500	DO,pH,Nuts,Pig	
8S	120	101511	02:42	03:02	07-59.96S	080-30.11E	5382.0	495.5	500.8	504.2	8SM120	2011101503	-	
8S	121	101511	05:41	06:30	08-00.08S	080-30.06E	5382.0	998.9	1000.2	1007.8	8SM121	2011101506	DO,Sal,pH,Nuts,Pig	
8S	122	101511	08:40	09:01	08-00.02S	080-29.92E	5384.0	494.8	502.3	505.0	8SM122	2011101509	-	
8S	123	101511	11:40	12:17	08-00.01S	080-29.91E	5385.0	497.6	501.4	504.4	8SM123	2011101512	DO,pH,Nuts,Pig	
8S	124	101511	14:41	15:02	07-59.06S	080-29.14E	5382.0	497.8	500.8	504.5	8SM124	2011101515	-	
8S	125	101511	17:40	18:12	08-00.14S	080-29.98E	5382.0	497.0	500.3	503.8	8SM125	2011101518	DO,pH,Nuts,Pig	
8S	126	101511	20:40	21:00	07-59.94S	080-30.03E	5383.0	497.2	500.8	504.5	8SM126	2011101521	-	
8S	127	101511	23:41	00:16	08-00.02S	080-29.98E	5383.0	498.1	503.3	506.8	8SM127	2011101600	DO,pH,Nuts,Pig	
8S	128	101611	02:42	03:02	07-59.97S	080-30.08E	5383.0	498.5	501.7	505.1	8SM128	2011101603	-	
8S	129	101611	05:39	06:29	08-00.09S	080-30.02E	5381.0	999.8	1000.8	1010.0	8SM129	2011101606	DO,Sal,pH,Nuts,Pig	
8S	130	101611	08:40	09:00	08-00.06S	080-30.11E	5383.0	494.8	500.6	504.3	8SM130	2011101609	-	The data of scan number 66000 was deleted due to the problem of data process.
8S	131	101611	11:39	12:13	07-59.96S	080-29.91E	5383.0	498.7	500.8	504.0	8SM131	2011101612	DO,pH,Nuts,Pig	
8S	132	101611	14:40	15:01	07-58.99S	080-29.15E	5382.0	495.5	501.3	503.2	8SM132	2011101615	-	
8S	133	101611	17:40	18:13	08-00.08S	080-29.92E	5382.0	497.6	501.1	504.6	8SM133	2011101618	DO,pH,Nuts,Pig	
8S	134	101611	20:39	21:00	08-00.20S	080-29.85E	5382.0	496.5	500.9	504.5	8SM134	2011101621	-	
8S	135	101611	23:41	00:17	08-00.06S	080-29.97E	5383.0	497.8	500.7	503.4	8SM135	2011101700	DO,pH,Nuts,Pig	
8S	136	101711	02:42	03:03	08-00.10S	080-29.95E	5381.0	497.6	501.5	505.1	8SM136	2011101703	-	
8S	137	101711	05:40	06:30	08-00.21S	080-30.02E	5381.0	998.7	1000.2	1009.4	8SM137	2011101706	DO,Sal,pH,Nuts,Pig	
8S	138	101711	08:40	09:00	08-00.12S	080-29.95E	5383.0	496.8	500.5	507.4	8SM138	2011101709	-	
8S	139	101711	12:00	12:34	08-00.32S	080-29.57E	5382.0	498.7	502.5	504.6	8SM139	2011101712	DO,pH,Nuts,Pig	
8S	140	101711	14:42	15:02	07-59.95S	080-29.87E	5384.0	498.5	500.2	503.0	8SM140	2011101715	-	
8S	141	101711	17:42	18:16	08-00.13S	080-29.74E	5382.0	498.3	502.4	505.3	8SM141	2011101718	DO,pH,Nuts,Pig	
8S	142	101711	20:39	21:00	07-59.93S	080-29.99E	5383.0	498.5	501.7	505.1	8SM142	2011101721	-	
8S	143	101711	23:41	00:16	08-00.04S	080-29.94E	5383.0	499.4	501.5	505.2	8SM143	2011101800	DO,pH,Nuts,Pig	
8S	144	101811	02:43	03:03	08-00.17S	080-29.52E	5381.0	497.9	501.7	505.1	8SM144	2011101803	-	
8S	145	101811	05:41	06:30	08-00.27S	080-30.08E	5383.0	999.8	1001.3	1009.0	8SM145	2011101806	DO,Sal,pH,Nuts,Pig	
8S	146	101811	08:40	09:01	08-00.02S	080-29.96E	5384.0	495.2	501.8	503.6	8SM146	2011101809	-	
8S	147	101811	11:39	12:15	08-00.06S	080-29.85E	5383.0	497.8	501.8	505.9	8SM147	2011101812	DO,pH,Nuts,Pig	
8S	148	101811	14:41	15:01	07-58.81S	080-29.20E	5362.0	496.6	500.5	502.1	8SM148	2011101815	-	
8S	149	101811	17:40	18:13	07-59.94S	080-29.93E	5383.0	498.1	501.6	505.0	8SM149	2011101818	DO,pH,Nuts,Pig	
8S	150	101811	20:40	21:00	08-00.03S	080-30.01E	5383.0	499.4	501.5	505.1	8SM150	2011101821	-	
8S	151	101811	23:41	00:17	08-00.07S	080-30.02E	5382.0	498.1	501.1	504.5	8SM151	2011101900	DO,pH,Nuts,Pig	
8S	152	101911	02:41	03:02	08-00.02S	080-30.08E	5384.0	497.6	500.4	503.8	8SM152	2011101903	-	
8S	153	101911	05:40	06:29	08-00.09S	080-29.82E	5384.0	998.5	1002.6	1008.4	8SM153	2011101906	DO,Sal,pH,Nuts,Pig	
8S	154	101911	08:40	09:00	08-00.03S	080-30.06E	5382.0	496.6	501.5	504.7	8SM154	2011101909	-	
8S	155	101911	11:40	12:15	07-59.96S	080-30.03E	5382.0	498.5	500.9	504.7	8SM155	2011101912	DO,pH,Nuts,Pig	
8S	156	101911	14:40	15:01	07-58.72S	080-29.58E	5303.0	498.9	501.5	505.2	8SM156	2011101915	-	
8S	157	101911	17:40	18:12	08-00.01S	080-30.06E	5383.0	496.8	500.3	503.4	8SM157	2011101918	DO,pH,Nuts,Pig	
8S	158	101911	20:40	21:01	07-59.93S	080-30.10E	5383.0	497.4	500.6	503.9	8SM158	2011101921	-	
8S	159	101911	23:41	00:17	07-59.95S	080-30.04E	5384.0	498.5	501.6	505.0	8SM159	2011102000	DO,pH,Nuts,Pig	
8S	160	102011	02:41	03:01	07-59.99S	080-30.28E	5385.0	497.9	501.3	504.7	8SM160	2011102003	-	
8S	161	102011	05:40	06:12	07-59.99S	080-31.92E	5386.0	497.4	500.2	503.6	8SM161	2011102006	DO,pH,Nuts,Pig	The bottom depth of this cast was changed from 1000db to 500db, because TurboMAP had priority at this cast.
8S	162	102011	08:41	09:10	08-00.06S	080-31.80E	5384.0	497.6	501.9	504.3	8SM162	2011102009	-	
8S	163	102011	11:39	12:14	07-59.97S	080-31.67E	5389.0	498.1	501.0	504.4	8SM163	2011102012	DO,pH,Nuts,Pig	
8S	164	102011	14:41	15:01	07-59.84S	080-31.51E	5387.0	497.8	501.8	504.1	8SM164	2011102015	-	
8S	165	102011	17:41	18:14	08-00.02S	080-31.38E	5387.0	498.1	501.5	504.9	8SM165	2011102018	DO,pH,Nuts,Pig	
8S	166	102011	20:39	21:01	07-59.97S	080-31.45E	5387.0	498.1	500.7	504.1	8SM166	2011102021	-	
8S	167	102011	23:41	00:17	07-59.90S	080-31.59E	5385.0	498.9	502.1	505.5	8SM167	2011102100	DO,pH,Nuts,Pig	
8S	168	102111	02:41	03:02	07-59.83S	080-31.33E	5385.0	499.0	501.0	504.5	8SM168	2011102103	-	
8S	169	102111	05:39	06:30	07-59.97S	080-30.95E	5385.0	999.6	1001.2	1009.5	8SM169	2011102106	DO,Sal,pH,Nuts,Pig	
8S	170	102111	08:40	09:09	08-00.06S	080-29.86E	5383.0	497.2	502.4	505.5	8SM170	2011102109	-	

Table 5.14-1 CTD Cast table

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire Out	Max Depth	Max Pressure	CTD Filename	COR Filename	Sampling	Remark
		(mmddyy)	Start	End	Latitude	Longitude								
8S	171	102111	12:31	13:10	07-59.84S	080-29.78E	5384.0	599.2	600.2	605.0	8SM171	2011102112	DO,pH,Nuts,Pig	The bottom depth of this cast changed from 500db to 600db, and the water sampling of 500m was canceled.
8S	172	102111	14:41	15:05	07-58.70S	080-29.93E	5291.0	497.8	500.3	503.8	8SM172	2011102115	-	
8S	173	102111	17:41	18:16	07-59.98S	080-29.96E	5384.0	498.7	500.8	504.2	8SM173	2011102118	DO,pH,Nuts,Pig	
8S	174	102111	20:39	20:59	07-59.97S	080-30.00E	5383.0	497.9	501.1	503.6	8SM174	2011102121	-	
8S	175	102111	23:57	00:32	08-00.01S	080-29.90E	5382.0	500.3	502.9	506.4	8SM175	2011102200	DO,pH,Nuts,Pig	
8S	176	102211	02:40	03:02	08-00.13S	080-29.75E	5388.0	498.7	500.8	504.3	8SM176	2011102203	-	
8S	177	102211	05:39	06:30	08-00.00S	080-29.96E	5383.0	997.9	1001.7	1007.6	8SM177	2011102206	DO,Sal,pH,Nuts,Pig	
8S	178	102211	08:40	09:00	08-00.17S	080-29.88E	5381.0	497.8	502.9	506.0	8SM178	2011102209	-	
8S	179	102211	11:40	12:13	08-00.04S	080-29.86E	5384.0	499.6	502.0	506.5	8SM179	2011102212	DO,pH,Nuts,Pig	
8S	180	102211	14:41	15:02	07-58.96S	080-29.36E	5384.0	499.4	502.0	505.4	8SM180	2011102215	-	
8S	181	102211	17:51	18:24	08-00.00S	080-30.04E	5386.0	497.6	502.2	506.7	8SM181	2011102218	DO,pH,Nuts,Pig	
8S	182	102211	20:39	21:00	08-00.10S	080-30.12E	5384.0	499.6	502.3	505.7	8SM182	2011102221	-	
8S	183	102211	23:41	00:17	08-00.01S	080-30.04E	5385.0	500.5	502.2	505.7	8SM183	2011102300	DO,pH,Nuts,Pig	
8S	184	102311	02:40	03:01	08-00.13S	080-29.99E	5382.0	499.0	502.2	505.6	8SM184	2011102303	-	
8S	185	102311	05:40	06:29	08-00.06S	080-29.98E	5382.0	997.4	1000.6	1007.3	8SM185	2011102306	DO,Sal,pH,Nuts,Pig	
8S	186	102311	08:39	09:00	08-00.19S	080-29.95E	5381.0	500.0	503.7	506.4	8SM186	2011102309	-	
8S	187	102311	11:39	12:13	07-59.97S	080-30.03E	5384.0	499.6	501.8	505.3	8SM187	2011102312	DO,pH,Nuts,Pig	
8S	188	102311	14:40	15:01	07-59.88S	080-30.01E	5383.0	498.1	500.4	503.8	8SM188	2011102315	-	
8S	189	102311	17:41	18:12	08-00.02S	080-29.86E	5383.0	499.8	502.4	504.9	8SM189	2011102318	DO,pH,Nuts,Pig	
8S	190	102311	20:38	21:00	08-00.07S	080-30.09E	5384.0	500.1	502.6	506.0	8SM190	2011102321	-	
8S	191	102311	23:40	00:15	08-00.04S	080-30.02E	5382.0	500.0	502.1	505.7	8SM191	2011102400	DO,pH,Nuts,Pig	
8S	192	102411	02:40	03:01	08-00.26S	080-29.92E	5382.0	498.9	501.9	505.2	8SM192	2011102403	-	
8S	193	102411	05:42	06:33	08-00.39S	080-29.81E	5384.0	997.6	1000.4	1008.1	8SM193	2011102406	DO,Sal,pH,Nuts,Pig	End of Leg1
8S	194	103011	23:39	00:15	08-00.01S	080-29.83E	5385.0	500.3	501.1	504.5	8SM194	2011103100	DO,pH,Nuts,Pig	Start of Leg2
8S	195	103111	02:41	03:02	08-00.12S	080-29.91E	5381.0	495.9	499.7	502.8	8SM195	2011103103	-	
8S	196	103111	05:39	06:29	08-00.06S	080-30.01E	5384.0	998.1	1000.8	1008.9	8SM196	2011103106	DO,Sal,pH,Nuts,Pig	
8S	197	103111	08:38	08:59	08-00.10S	080-30.01E	5384.0	497.9	502.0	505.0	8SM197	2011103109	-	
8S	198	103111	11:40	12:15	08-00.04S	080-30.02E	5382.0	499.2	502.6	506.5	8SM198	2011103112	DO,pH,Nuts,Pig	
8S	199	103111	14:39	15:00	07-59.94S	080-29.64E	5383.0	499.4	501.2	504.4	8SM199	2011103115	-	
8S	200	103111	17:38	18:12	08-00.10S	080-29.96E	5384.0	497.9	502.5	506.0	8SM200	2011103118	DO,pH,Nuts,Pig	
8S	201	103111	20:39	20:59	08-00.07S	080-29.93E	5383.0	500.7	503.1	506.5	8SM201	2011103121	-	
8S	202	103111	23:39	00:15	08-00.03S	080-30.01E	5382.0	499.2	500.7	503.5	8SM202	2011110100	DO,pH,Nuts,Pig	
8S	203	110111	02:39	03:00	07-59.91S	080-30.10E	5390.0	497.2	500.7	504.3	8SM203	2011110103	-	The data of scan number from 22723 to 23963 was deleted, because the upcast data of about 10m was included during downcast.
8S	204	110111	05:39	06:29	07-59.93S	080-29.99E	5385.0	999.8	1001.0	1009.2	8SM204	2011110106	DO,Sal,pH,Nuts,Pig	
8S	205	110111	08:39	08:59	08-00.00S	080-30.08E	5384.0	498.5	500.8	504.4	8SM205	2011110109	-	
8S	206	110111	11:42	12:16	07-59.93S	080-29.95E	5384.0	497.4	502.4	505.7	8SM206	2011110112	DO,pH,Nuts,Pig	
8S	207	110111	14:39	15:00	08-00.00S	080-29.77E	5385.0	497.6	501.6	505.5	8SM207	2011110115	-	
8S	208	110111	17:39	18:14	08-00.23S	080-30.02E	5383.0	499.0	501.4	504.7	8SM208	2011110118	DO,pH,Nuts,Pig	
8S	209	110111	20:39	21:00	07-59.95S	080-29.99E	5382.0	498.9	502.5	506.0	8SM209	2011110121	-	
8S	210	110111	23:38	00:13	08-00.05S	080-29.83E	5383.0	497.4	501.1	504.2	8SM210	2011110200	DO,pH,Nuts,Pig	
8S	211	110211	02:39	03:01	07-59.98S	080-29.97E	5383.0	497.2	501.0	504.2	8SM211	2011110203	-	
8S	212	110211	05:39	06:29	08-00.06S	080-29.97E	5382.0	999.6	1002.0	1010.1	8SM212	2011110206	DO,Sal,pH,Nuts,Pig	
8S	213	110211	08:39	08:59	08-00.10S	080-29.82E	5383.0	498.3	501.1	504.3	8SM213	2011110209	-	
8S	214	110211	11:38	12:13	07-59.93S	080-29.62E	5384.0	498.1	501.3	504.8	8SM214	2011110212	DO,pH,Nuts,Pig	
8S	215	110211	14:45	15:07	07-59.90S	080-29.96E	5384.0	495.5	500.8	503.3	8SM215	2011110215	-	
8S	216	110211	17:43	18:17	08-00.02S	080-29.99E	5383.0	496.6	502.9	505.9	8SM216	2011110218	DO,pH,Nuts,Pig	
8S	217	110211	20:43	21:04	07-59.98S	080-30.10E	5383.0	498.3	502.7	506.1	8SM217	2011110221	-	
8S	218	110211	23:40	00:15	07-59.95S	080-29.96E	5384.0	498.5	501.8	505.4	8SM218	2011110300	DO,pH,Nuts,Pig	
8S	219	110311	02:45	03:07	07-59.98S	080-30.12E	5383.0	499.0	502.3	505.1	8SM219	2011110303	-	
8S	220	110311	05:45	06:34	08-00.08S	080-29.97E	5383.0	998.3	1001.5	1009.4	8SM220	2011110306	DO,Sal,pH,Nuts,Pig	
8S	221	110311	08:44	09:04	07-59.87S	080-30.11E	5387.0	498.9	501.8	505.4	8SM221	2011110309	-	
8S	222	110311	11:45	12:19	08-00.17S	080-29.96E	5382.0	496.3	502.5	505.3	8SM222	2011110312	DO,pH,Nuts,Pig	
8S	223	110311	14:45	15:07	08-00.02S	080-29.97E	5384.0	497.9	502.8	506.0	8SM223	2011110315	-	
8S	224	110311	17:42	18:17	08-00.05S	080-30.06E	5383.0	499.0	501.2	505.0	8SM224	2011110318	DO,pH,Nuts,Pig	
8S	225	110311	20:43	21:03	07-59.98S	080-30.23E	5383.0	498.1	502.5	505.1	8SM225	2011110321	-	
8S	226	110311	23:45	00:19	07-59.86S	080-30.17E	5384.0	499.4	501.5	504.7	8SM226	2011110400	DO,pH,Nuts,Pig	
8S	227	110411	02:46	03:07	08-00.12S	080-29.93E	5383.0	497.0	501.4	504.2	8SM227	2011110403	-	
8S	228	110411	05:44	06:35	08-00.06S	080-30.07E	5383.0	998.7	1000.9	1008.8	8SM228	2011110406	DO,Sal,pH,Nuts,Pig	
8S	229	110411	08:43	09:04	08-00.00S	080-30.13E	5383.0	497.9	500.4	504.7	8SM229	2011110409	-	
8S	230	110411	11:43	12:17	08-00.14S	080-29.97E	5382.0	497.0	501.6	504.6	8SM230	2011110412	DO,pH,Nuts,Pig	
8S	231	110411	14:44	15:05	08-00.13S	080-29.78E	5383.0	496.1	500.4	504.2	8SM231	2011110415	-	
8S	232	110411	17:42	18:17	08-00.17S	080-30.09E	5382.0	498.1	500.9	504.4	8SM232	2011110418	DO,pH,Nuts,Pig	
8S	233	110411	20:41	21:02	08-00.00S	080-30.31E	5383.0	497.6	501.6	505.0	8SM233	2011110421	-	
8S	234	110411	23:43	00:17	08-00.00S	080-30.10E	5384.0	497.6	501.4	504.8	8SM234	2011110500	DO,pH,Nuts,Pig	
8S	235	110511	02:44	03:05	07-59.98S	080-29.91E	5384.0	496.1	500.4	504.2	8SM235	2011110503	-	
8S	236	110511	05:45	06:35	07-59.90S	080-30.21E	5384.0	999.6	1001.6	1008.7	8SM236	2011110506	DO,Sal,pH,Nuts,Pig	
8S	237	110511	08:43	09:03	08-00.03S	080-30.00E	5383.0	497.0	501.4	505.1	8SM237	2011110509	-	
8S	238	110511	11:44	12:18	07-59.78S	080-29.99E	5387.0	496.8	500.4	503.7	8SM238	2011110512	DO,pH,Nuts,Pig	
8S	239	110511	14:44	15:05	08-00.65S	080-29.73E	5382.0	496.5	500.4	504.2	8SM239	2011110515	-	
8S	240	110511	17:41	18:17	07-59.93S	080-30.30E	5383.0	497.6	501.0	504.5	8SM240	2011110518	DO,pH,Nuts,Pig	
8S	241	110511	20:41	21:02	07-59.99S	080-30.08E	5383.0	497.2	501.2	505.2	8SM241	2011110521	-	
8S	242	110511	23:43	00:20	08-00.13S	080-30.02E	5383.0	498.5	501.7	505.2	8SM242	2011110600	DO,pH,Nuts,Pig	Water samples of 60m, 40m, 20m and 10m were not collected, due to water sampler trouble.
8S	243	110611	03:32	03:52	07-59.69S	080-29.75E	5384.0	498.7	502.4	505.3	8SM243	2011110603	-	
8S	244	110611	05:44	06:34	07-59.99S	080-30.08E	5383.0	999.0	1001.8	1009.8	8SM244	2011110606	DO,Sal,pH,Nuts,Pig	
8S	245	110611	08:45	09:05	08-00.05S	080-29.95E	5383.0	499.2	501.8	505.8	8SM245	2011110609	-	
8S	246	110611	11:44	12:17	08-00.03S	080-29.85E	5382.0	497.0	501.0	505.1	8SM246	2011110612	DO,pH,Nuts,Pig	
8S	247	110611	14:44	15:05	08-00.10S	080-29.79E	5383.0	497.9	502.4	506.4	8SM247	2011110615	-	
8S	248	110611	17:41	18:16	07-59.98S	080-30.04E	5384.0	498.1	502.0	505.4	8SM248	2011110618	DO,pH,Nuts,Pig	
8S	249	110611	20:40	21:01	07-59.87S	080-30.16E	5390.0	496.6	500.0	502.6	8SM249	2011110621	-	
8S	250	110611	23:42	00:15	07-59.89S	080-30.07E	5384.0	497.8	501.5	506.0	8SM250	2011110700	DO,pH,Nuts,Pig	
8S	251	110711	02:45	03:06	08-00.09S	080-29.89E	5384.0	497.2	500.9	504.7	8SM251	2011110703	-	
8S	252	110711	05:44	06:33	08-00.06S	080-29.94E	5383.0	997.9	999.8	1007.8	8SM252	2011110706	DO,Sal,pH,Nuts,Pig	
8S	253	110711	08:44	09:04	08-00.14S	080-29.80E	5384.0	495.4	501.2	504.1	8SM253	2011110709	-	
8S	254	110711	11:43	12:17	08-00.19S	080-29.77E	5381.0	497.8	501.9	505.3	8SM254	2011110712	DO,pH,Nuts,Pig	
8S	255	110711	14:44	15:05	08-00.06S	080-29.84E	5382.0	496.3	501.5	504.5	8SM255	2011110715	-	
8S	256	110711	17:42	18:17	08-00.14S	080-30.05E	5383.0	498.9	501.7	505.4	8SM256	2011110718	DO,pH,Nuts,Pig	
8S	257	110711	20:40	21:01	08-00.02S	080-29.97E	5384.0	497.4	502.8	505.6	8SM257	2011110721	-	
8S	258	110711	23:42	00:15	08-00.06S	080-29.96E	5382.0	497.9	501.1	504.6	8SM258	2011110800	DO,pH,Nuts,Pig	

Table 5.14-1 CTD Cast table

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire Out	Max Depth	Max Pressure	CTD Filename	COR Filename	Sampling	Remark
		(mmddyy)	Start	End	Latitude	Longitude								
8S	259	110811	02:45	03:06	07-59.83S	080-29.85E	5385.0	497.9	502.3	505.0	8SM259	2011110803	-	
8S	260	110811	05:45	06:35	07-59.99S	080-29.99E	5386.0	999.8	1000.3	1009.7	8SM260	2011110806	DO,Sal,pH,Nuts,Pig	
8S	261	110811	08:43	09:03	08-00.12S	080-29.92E	5383.0	496.5	500.5	504.3	8SM261	2011110809	-	
8S	262	110811	11:43	12:17	08-00.13S	080-29.87E	5382.0	497.4	501.3	505.0	8SM262	2011110812	DO,pH,Nuts,Pig	
8S	263	110811	14:43	15:05	07-59.96S	080-29.96E	5383.0	497.0	500.8	504.4	8SM263	2011110815	-	
8S	264	110811	17:42	18:16	08-00.14S	080-29.93E	5383.0	497.8	501.3	504.8	8SM264	2011110818	DO,pH,Nuts,Pig	
8S	265	110811	20:42	21:03	07-59.96S	080-29.97E	5384.0	496.3	499.5	502.6	8SM265	2011110821	-	
8S	266	110811	23:42	00:16	08-00.08S	080-29.98E	5382.0	497.9	501.2	504.6	8SM266	2011110900	DO,pH,Nuts,Pig	
8S	267	110911	02:44	03:05	07-59.98S	080-29.91E	5384.0	498.7	500.3	503.8	8SM267	2011110903	-	
8S	268	110911	05:43	06:33	08-00.01S	080-29.93E	5383.0	1000.5	1003.1	1011.4	8SM268	2011110906	DO,Sal,pH,Nuts,Pig	
8S	269	110911	08:43	09:03	08-00.12S	080-30.00E	5384.0	498.3	500.4	505.4	8SM269	2011110909	-	
8S	270	110911	11:44	12:17	08-00.02S	080-29.97E	5384.0	498.9	502.0	504.5	8SM270	2011110912	DO,pH,Nuts,Pig	
8S	271	110911	14:44	15:05	08-00.17S	080-29.93E	5383.0	498.1	503.0	505.9	8SM271	2011110915	-	
8S	272	110911	17:43	18:18	08-00.27S	080-29.75E	5382.0	500.9	502.8	506.1	8SM272	2011110918	DO,pH,Nuts,Pig	
8S	273	110911	20:40	21:01	08-00.14S	080-29.90E	5384.0	498.5	501.4	505.2	8SM273	2011110921	-	
8S	274	110911	23:44	00:17	08-00.13S	080-29.76E	5383.0	499.6	502.2	505.5	8SM274	2011111000	DO,pH,Nuts,Pig	
8S	275	111011	02:45	03:06	08-00.09S	080-29.76E	5382.0	499.6	500.9	504.7	8SM275	2011111003	-	
8S	276	111011	05:44	06:33	08-00.02S	080-29.83E	5386.0	999.0	1000.4	1008.7	8SM276	2011111006	DO,Sal,pH,Nuts,Pig	
8S	277	111011	08:43	09:03	08-00.05S	080-30.03E	5383.0	499.2	502.4	505.9	8SM277	2011111009	-	
8S	278	111011	11:44	12:18	08-00.00S	080-29.71E	5385.0	498.3	501.2	504.7	8SM278	2011111012	DO,pH,Nuts,Pig	
8S	279	111011	14:43	15:04	08-00.03S	080-29.57E	5382.0	499.0	502.7	506.3	8SM279	2011111015	-	
8S	280	111011	17:41	18:15	08-00.02S	080-30.02E	5383.0	498.5	500.8	504.2	8SM280	2011111018	DO,pH,Nuts,Pig	
8S	281	111011	20:40	21:00	07-59.95S	080-30.02E	5386.0	499.2	502.7	506.1	8SM281	2011111021	-	
8S	282	111011	23:43	00:16	07-59.97S	080-30.01E	5383.0	498.5	502.0	505.3	8SM282	2011111100	DO,pH,Nuts,Pig	
8S	283	111111	02:43	03:04	07-59.99S	080-29.93E	5382.0	495.9	500.2	503.9	8SM283	2011111103	-	
8S	284	111111	05:44	06:34	08-00.00S	080-29.88E	5384.0	998.3	1000.4	1007.3	8SM284	2011111106	DO,Sal,pH,Nuts,Pig	
8S	285	111111	08:50	09:11	08-00.06S	080-29.81E	5385.0	499.0	501.2	504.1	8SM285	2011111109	-	
8S	286	111111	11:43	12:18	07-59.95S	080-30.04E	5383.0	497.8	501.3	504.6	8SM286	2011111112	DO,pH,Nuts,Pig	
8S	287	111111	14:44	15:05	07-59.96S	080-29.96E	5382.0	497.8	501.5	504.1	8SM287	2011111115	-	
8S	288	111111	17:41	18:16	08-00.13S	080-30.10E	5382.0	499.4	503.0	506.7	8SM288	2011111118	DO,pH,Nuts,Pig	
8S	289	111111	20:41	21:03	08-00.09S	080-30.09E	5384.0	497.6	500.7	504.1	8SM289	2011111121	-	
8S	290	111111	23:43	00:18	07-59.96S	080-29.94E	5384.0	499.2	501.8	505.4	8SM290	2011111200	DO,pH,Nuts,Pig	
8S	291	111211	02:44	03:05	08-00.09S	080-29.94E	5382.0	495.7	499.9	503.6	8SM291	2011111203	-	
8S	292	111211	05:45	06:35	08-00.22S	080-29.75E	5382.0	998.7	1000.3	1007.9	8SM292	2011111206	DO,Sal,pH,Nuts,Pig	
8S	293	111211	08:45	09:06	08-00.18S	080-30.05E	5383.0	497.4	500.7	504.4	8SM293	2011111209	-	
8S	294	111211	11:38	12:13	08-00.15S	080-29.90E	5384.0	498.9	502.0	505.4	8SM294	2011111212	DO,pH,Nuts,Pig	
8S	295	111211	14:44	15:05	08-00.09S	080-29.97E	5381.0	498.1	502.7	505.5	8SM295	2011111215	-	
8S	296	111211	17:42	18:17	07-59.99S	080-29.92E	5385.0	500.1	501.6	505.0	8SM296	2011111218	DO,pH,Nuts,Pig	
8S	297	111211	20:56	21:17	07-59.78S	080-29.87E	5387.0	500.1	503.8	506.0	8SM297	2011111221	-	
8S	298	111211	23:44	00:19	07-59.72S	080-29.91E	5384.0	498.3	501.0	504.3	8SM298	2011111300	DO,pH,Nuts,Pig	
8S	299	111311	02:40	03:01	07-59.78S	080-29.93E	5384.0	498.7	501.3	504.9	8SM299	2011111303	-	
8S	300	111311	05:47	06:37	07-59.86S	080-29.97E	5385.0	998.9	1000.8	1008.8	8SM300	2011111306	DO,Sal,pH,Nuts,Pig	
8S	301	111311	08:39	09:00	07-59.88S	080-29.97E	5383.0	497.6	501.3	505.7	8SM301	2011111309	-	
8S	302	111311	11:42	12:17	07-59.90S	080-29.99E	5385.0	497.6	500.5	504.2	8SM302	2011111312	DO,pH,Nuts,Pig	
8S	303	111311	14:48	15:08	08-00.02S	080-29.99E	5383.0	497.4	501.4	504.8	8SM303	2011111315	-	
8S	304	111311	17:42	18:17	08-00.05S	080-30.03E	5382.0	500.5	502.7	506.3	8SM304	2011111318	DO,pH,Nuts,Pig	
8S	305	111311	20:40	21:01	08-00.12S	080-30.03E	5383.0	499.0	503.0	505.4	8SM305	2011111321	-	
8S	306	111311	23:43	00:18	07-59.98S	080-29.84E	5384.0	497.8	501.6	504.2	8SM306	2011111400	DO,pH,Nuts,Pig	
8S	307	111411	02:43	03:04	07-59.96S	080-29.87E	5384.0	495.9	500.2	503.7	8SM307	2011111403	-	
8S	308	111411	05:42	06:32	07-59.98S	080-29.90E	5384.0	1000.1	1002.4	1010.3	8SM308	2011111406	DO,Sal,pH,Nuts,Pig	
8S	309	111411	08:42	09:02	08-00.04S	080-29.68E	5385.0	498.1	501.6	504.5	8SM309	2011111409	-	
8S	310	111411	11:43	12:18	08-00.08S	080-29.79E	5382.0	497.0	500.4	503.2	8SM310	2011111412	DO,pH,Nuts,Pig	
8S	311	111411	14:42	15:03	08-00.02S	080-29.70E	5384.0	496.5	500.5	504.4	8SM311	2011111415	-	
8S	312	111411	17:42	18:17	08-00.10S	080-29.84E	5382.0	497.0	500.2	504.3	8SM312	2011111418	DO,pH,Nuts,Pig	
8S	313	111411	20:43	21:05	08-00.25S	080-30.01E	5383.0	497.2	501.8	503.2	8SM313	2011111421	-	
8S	314	111411	23:43	00:18	08-00.03S	080-29.87E	5385.0	497.8	501.4	504.6	8SM314	2011111500	DO,pH,Nuts,Pig	
8S	315	111511	02:44	03:05	07-59.92S	080-29.88E	5384.0	497.6	500.8	504.6	8SM315	2011111503	-	
8S	316	111511	05:43	06:33	08-00.37S	080-29.93E	5383.0	998.7	1002.6	1010.7	8SM316	2011111506	DO,Sal,pH,Nuts,Pig	
8S	317	111511	08:43	09:04	08-00.26S	080-30.00E	5388.0	498.7	501.5	504.6	8SM317	2011111509	-	
8S	318	111511	11:45	12:20	07-59.99S	080-29.88E	5390.0	497.9	501.0	504.3	8SM318	2011111512	DO,pH,Nuts,Pig	
8S	319	111511	14:42	15:03	08-00.17S	080-29.92E	5381.0	497.4	501.2	504.0	8SM319	2011111515	-	
8S	320	111511	17:41	18:17	08-00.06S	080-30.02E	5383.0	499.2	501.8	505.7	8SM320	2011111518	DO,pH,Nuts,Pig	
8S	321	111511	20:43	21:03	08-00.11S	080-29.97E	5383.0	496.5	501.0	505.7	8SM321	2011111521	-	
8S	322	111511	23:43	00:18	08-00.16S	080-29.99E	5382.0	497.6	500.4	503.5	8SM322	2011111600	DO,pH,Nuts,Pig	
8S	323	111611	02:42	03:04	08-00.08S	080-29.81E	5385.0	496.6	500.7	504.1	8SM323	2011111603	-	
8S	324	111611	05:42	06:32	08-00.05S	080-29.84E	5384.0	999.6	1001.0	1009.0	8SM324	2011111606	DO,Sal,pH,Nuts,Pig	
8S	325	111611	08:42	09:03	08-00.24S	080-29.95E	5383.0	498.1	500.2	503.7	8SM325	2011111609	-	
8S	326	111611	11:43	12:19	07-59.93S	080-30.03E	5385.0	498.7	501.3	504.2	8SM326	2011111612	DO,pH,Nuts,Pig	
8S	327	111611	14:42	15:03	08-00.25S	080-29.98E	5383.0	497.4	500.5	503.7	8SM327	2011111615	-	
8S	328	111611	17:41	18:16	08-00.11S	080-29.92E	5383.0	499.4	501.5	505.0	8SM328	2011111618	DO,pH,Nuts,Pig	
8S	329	111611	20:42	21:03	08-00.19S	080-29.98E	5383.0	497.8	500.8	504.3	8SM329	2011111621	-	
8S	330	111611	23:43	00:17	08-00.27S	080-30.03E	5383.0	497.2	500.0	503.3	8SM330	2011111700	DO,pH,Nuts,Pig	
8S	331	111711	02:43	03:04	08-00.12S	080-30.17E	5388.0	497.0	500.1	502.7	8SM331	2011111703	-	
8S	332	111711	05:42	06:32	08-00.14S	080-29.96E	5382.0	1000.0	1001.4	1009.5	8SM332	2011111706	DO,Sal,pH,Nuts,Pig	
8S	333	111711	08:44	09:04	08-00.04S	080-30.02E	5383.0	496.5	500.4	503.3	8SM333	2011111709	-	
8S	334	111711	11:42	12:17	08-00.01S	080-30.04E	5386.0	498.3	500.6	504.0	8SM334	2011111712	DO,pH,Nuts,Pig	The fluorescence data at 60 m in the CTD bottle data was except for spike and processed.
8S	335	111711	14:43	15:04	08-00.04S	080-30.05E	5383.0	497.9	501.4	504.2	8SM335	2011111715	-	
8S	336	111711	17:42	18:17	08-00.02S	080-29.92E	5383.0	498.3	502.2	505.7	8SM336	2011111718	DO,pH,Nuts,Pig	
8S	337	111711	20:41	21:03	07-59.97S	080-30.01E	5384.0	497.9	502.6	505.5	8SM337	2011111721	-	
8S	338	111711	23:42	00:19	08-00.01S	080-29.94E	5385.0	497.2	501.1	504.7	8SM338	2011111800	DO,pH,Nuts,Pig	
8S	339	111811	02:42	03:04	08-00.03S	080-29.92E	5384.0	496.3	500.1	503.8	8SM339	2011111803	-	
8S	340	111811	05:43	06:32	08-00.23S	080-29.62E	5382.0	998.7	1000.7	1008.7	8SM340	2011111806	DO,Sal,pH,Nuts,Pig	
8S	341	111811	08:43	09:03	08-00.11S	080-29.88E	5382.0	498.3	501.6	505.3	8SM341	2011111809	-	
8S	342	111811	11:43	12:19	08-00.14S	080-29.57E	5386.0	498.3	501.2	504.7	8SM342	2011111812	DO,pH,Nuts,Pig	
8S	343	111811	14:43	15:05	08-00.24S	080-29.61E	5381.0	497.6	500.9	503.6	8SM343	2011111815	-	
8S	344	111811	17:48	18:23	08-00.25S	080-29.85E	5383.0	497.8	501.2	504.3	8SM344	2011111818	DO,pH,Nuts,Pig	
8S	345	111811	20:43	21:04	08-00.08S	080-30.03E	5383.0	497.2	501.8	504.9	8SM345	2011111821	-	
8S	346	111811	23:44	00:19	08-00.12S	080-29.90E	5384.0	497.0	500.0	503.5	8SM346	2011111900	DO,pH,Nuts,Pig	
8S	347	111911	02:46	03:08	08-00.09S	080-30.04E	5384.0	496.6	500.3	503.8	8SM347	2011111903	-	
8S	348	111911	05:43	06:34	08-00.34S	080-29.89E	5388.0	999.2	1000.1	1008.7	8SM348	2011111906	DO,Sal,pH,Nuts,Pig	
8S	349	111911	08:43	09:05	08-00.12S	080-29.67E	5388.0	497.0	501.5	504.7	8SM349	2011111909	-	
8S	350	111911	11:42	12:18	08-00.19S	080-30.15E	5383.0	499.2	502.2	505.6	8SM350	2011111912	DO,pH,Nuts,Pig	
8S	351	111911	14:44	15:05	08-00.16S	080-30.41E	5383.0	498.1	500.9	503.9	8SM351	2011111915	-	
8S	352	111911	17:46	18:22	08-00.17S	080-29.64E	5383.0	500.7	503.2	505.7	8SM352	2011111918	DO,pH,Nuts,Pig	
8S	353	111911	20:42	21:03	08-00.00S	080-30.15E	5385.0	496.1	502.7	505.6	8SM353	2011111921	-	
8S	354	111911	23:42	00:17	08-00.20S	080-30.08E	5383.0	499.6	501.9	505.2	8SM354	2011112000	DO,pH,Nuts,Pig	

Table 5.14-1 CTD Cast table

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire Out	Max Depth	Max Pressure	CTD Filename	COR Filename	Sampling	Remark
		(mmddyy)	Start	End	Latitude	Longitude								
8S	355	112011	02:44	03:06	08-00.18S	080-30.57E	5384.0	497.0	501.0	504.4	8SM355	2011112003	-	
8S	356	112011	05:42	06:33	07-59.99S	080-30.27E	5384.0	1000.1	1000.8	1009.1	8SM356	2011112006	DO,Sal,pH,Nuts,Pig	
8S	357	112011	08:42	09:03	08-00.22S	080-30.02E	5385.0	497.6	500.6	505.1	8SM357	2011112009	-	
8S	358	112011	11:42	12:17	07-59.98S	080-30.07E	5384.0	497.9	500.8	504.1	8SM358	2011112012	DO,pH,Nuts,Pig	
8S	359	112011	14:47	15:08	08-00.15S	080-30.04E	5384.0	496.8	501.7	504.5	8SM359	2011112015	-	
8S	360	112011	17:43	18:19	08-00.13S	080-30.04E	5382.0	497.9	501.2	504.3	8SM360	2011112018	DO,pH,Nuts,Pig	
8S	361	112011	20:41	21:03	07-59.97S	080-30.00E	5384.0	495.0	499.9	503.5	8SM361	2011112021	-	
8S	362	112011	23:43	00:18	08-00.04S	080-29.92E	5384.0	497.2	500.2	503.5	8SM362	2011112100	DO,pH,Nuts,Pig	
8S	363	112111	02:42	03:04	08-00.07S	080-29.87E	5383.0	498.5	501.0	504.0	8SM363	2011112103	-	
8S	364	112111	05:42	06:32	07-59.91S	080-30.04E	5385.0	998.9	1001.4	1009.4	8SM364	2011112106	DO,Sal,pH,Nuts,Pig	
8S	365	112111	08:42	09:03	08-00.03S	080-29.85E	5385.0	499.4	500.5	505.8	8SM365	2011112109	-	
8S	366	112111	11:41	12:17	08-00.16S	080-29.84E	5383.0	497.2	501.8	505.4	8SM366	2011112112	DO,pH,Nuts,Pig	
8S	367	112111	14:45	15:06	08-00.19S	080-29.55E	5382.0	499.2	502.2	505.7	8SM367	2011112115	-	
8S	368	112111	17:44	18:16	08-00.07S	080-29.81E	5385.0	498.7	501.4	504.8	8SM368	2011112118	DO,pH,Nuts,Pig	
8S	369	112111	20:43	21:05	08-00.07S	080-30.13E	5384.0	497.9	502.1	505.4	8SM369	2011112121	-	
8S	370	112111	23:42	00:15	08-00.02S	080-29.93E	5384.0	498.5	501.7	505.1	8SM370	2011112200	DO,pH,Nuts,Pig	
8S	371	112211	02:43	03:04	08-00.09S	080-29.86E	5384.0	500.0	501.6	504.8	8SM371	2011112203	-	
8S	372	112211	05:43	06:31	08-00.01S	080-30.00E	5385.0	999.2	1000.1	1007.2	8SM372	2011112206	DO,Sal,pH,Nuts,Pig	
8S	373	112211	08:42	09:03	08-00.22S	080-29.85E	5384.0	499.0	502.3	506.6	8SM373	2011112209	-	
8S	374	112211	11:42	12:16	08-00.07S	080-29.81E	5383.0	498.3	501.8	505.2	8SM374	2011112212	DO,pH,Nuts,Pig	
8S	375	112211	14:42	15:03	08-00.05S	080-29.62E	5383.0	498.5	501.8	505.3	8SM375	2011112215	-	
8S	376	112211	17:42	18:16	08-00.20S	080-30.02E	5384.0	499.4	501.6	505.1	8SM376	2011112218	DO,pH,Nuts,Pig	
8S	377	112211	20:44	21:06	08-00.07S	080-29.90E	5383.0	498.1	500.9	504.1	8SM377	2011112221	-	
8S	378	112211	23:45	00:19	08-00.09S	080-30.08E	5383.0	497.9	503.0	506.5	8SM378	2011112300	DO,pH,Nuts,Pig	
8S	379	112311	02:42	03:03	08-00.24S	080-30.14E	5381.0	498.9	501.3	505.0	8SM379	2011112303	-	
8S	380	112311	05:42	06:32	08-00.08S	080-29.94E	5384.0	999.8	1001.2	1009.2	8SM380	2011112306	DO,Sal,pH,Nuts,Pig	
8S	381	112311	08:42	09:04	08-00.19S	080-29.86E	5383.0	498.7	500.4	504.1	8SM381	2011112309	-	
8S	382	112311	11:41	12:16	08-00.15S	080-29.90E	5383.0	499.4	501.2	504.8	8SM382	2011112312	DO,pH,Nuts,Pig	
8S	383	112311	14:42	15:03	08-00.04S	080-29.97E	5383.0	499.0	501.5	504.6	8SM383	2011112315	-	
8S	384	112311	17:43	18:17	08-00.24S	080-29.80E	5384.0	499.2	502.3	505.9	8SM384	2011112318	DO,pH,Nuts,Pig	
8S	385	112311	20:43	21:05	08-00.09S	080-29.97E	5384.0	498.5	501.7	504.5	8SM385	2011112321	-	
8S	386	112311	23:43	00:16	08-00.16S	080-30.04E	5383.0	498.5	501.1	504.5	8SM386	2011112400	DO,pH,Nuts,Pig	
8S	387	112411	02:56	03:17	08-00.24S	080-29.56E	5381.0	497.4	500.4	503.9	8SM387	2011112403	-	
8S	388	112411	05:44	06:33	08-00.18S	080-29.91E	5383.0	998.5	1000.2	1008.3	8SM388	2011112406	DO,Sal,pH,Nuts,Pig	
8S	389	112411	08:42	09:04	08-00.07S	080-29.90E	5382.0	497.4	501.0	505.3	8SM389	2011112409	-	
8S	390	112411	11:43	12:18	07-59.97S	080-30.09E	5382.0	499.4	502.2	505.6	8SM390	2011112412	DO,pH,Nuts,Pig	
8S	391	112411	14:44	15:05	08-00.02S	080-29.81E	5383.0	497.0	501.9	504.5	8SM391	2011112415	-	
8S	392	112411	17:46	18:20	08-00.20S	080-29.68E	5383.0	498.7	502.2	505.7	8SM392	2011112418	DO,pH,Nuts,Pig	
8S	393	112411	20:45	21:07	08-00.23S	080-29.93E	5386.0	497.8	502.2	505.6	8SM393	2011112421	-	
8S	394	112411	23:48	00:22	08-00.21S	080-29.97E	5383.0	498.5	501.6	505.5	8SM394	2011112500	DO,pH,Nuts,Pig	
8S	395	112511	02:44	03:06	08-00.16S	080-29.76E	5385.0	499.2	502.3	506.0	8SM395	2011112503	-	
8S	396	112511	05:44	06:37	08-00.15S	080-29.84E	5383.0	999.0	1001.7	1009.5	8SM396	2011112506	DO,Sal,pH,Nuts,Pig	
8S	397	112511	08:44	09:06	08-00.10S	080-29.92E	5384.0	499.4	501.7	506.3	8SM397	2011112509	-	
8S	398	112511	11:41	12:16	07-59.95S	080-30.00E	5383.0	497.9	501.1	504.7	8SM398	2011112512	DO,pH,Nuts,Pig	
8S	399	112511	14:41	15:04	07-59.88S	080-30.03E	5385.0	499.0	501.3	505.5	8SM399	2011112515	-	
8S	400	112511	17:44	18:23	07-59.92S	080-29.78E	5384.0	499.6	503.1	506.2	8SM400	2011112518	DO,pH,Nuts,Pig	
8S	401	112511	20:36	20:58	08-00.15S	080-30.01E	5385.0	497.8	501.3	505.3	8SM401	2011112521	-	
8S	402	112511	23:44	00:18	08-00.00S	080-30.11E	5384.0	499.0	501.9	505.3	8SM402	2011112600	DO,pH,Nuts,Pig	
8S	403	112611	02:41	03:03	08-00.16S	080-29.90E	5383.0	498.3	501.2	504.9	8SM403	2011112603	-	
8S	404	112611	05:43	06:35	08-00.16S	080-29.96E	5383.0	997.6	1000.3	1008.3	8SM404	2011112606	DO,Sal,pH,Nuts,Pig	
8S	405	112611	08:42	09:05	08-00.18S	080-30.25E	5386.0	498.3	500.2	506.1	8SM405	2011112609	-	
8S	406	112611	11:41	12:15	08-00.18S	080-29.81E	5384.0	498.5	501.2	504.6	8SM406	2011112612	DO,pH,Nuts,Pig	
8S	407	112611	14:41	15:03	08-00.03S	080-29.86E	5383.0	497.4	501.5	504.7	8SM407	2011112615	-	
8S	408	112611	17:43	18:19	07-59.97S	080-30.03E	5383.0	498.5	502.6	506.0	8SM408	2011112618	DO,pH,Nuts,Pig	
8S	409	112611	20:43	21:05	08-00.13S	080-30.04E	5384.0	496.5	502.0	504.7	8SM409	2011112621	-	
8S	410	112611	23:44	00:18	08-00.05S	080-29.88E	5383.0	498.9	500.9	505.5	8SM410	2011112700	DO,pH,Nuts,Pig	
8S	411	112711	02:42	03:04	08-00.15S	080-30.01E	5384.0	498.3	500.7	505.0	8SM411	2011112703	-	
8S	412	112711	05:42	06:35	08-00.18S	080-30.01E	5383.0	999.2	1001.3	1009.2	8SM412	2011112706	DO,Sal,pH,Nuts,Pig	
8S	413	112711	08:42	09:04	08-00.22S	080-29.88E	5384.0	495.7	500.8	503.6	8SM413	2011112709	-	
8S	414	112711	11:43	12:18	08-00.14S	080-29.85E	5385.0	498.5	502.2	505.6	8SM414	2011112712	DO,pH,Nuts,Pig	
8S	415	112711	14:41	15:02	08-00.03S	080-29.68E	5384.0	496.6	500.9	504.7	8SM415	2011112715	-	
8S	416	112711	17:43	18:19	08-00.06S	080-30.08E	5384.0	500.1	502.6	506.0	8SM416	2011112718	DO,pH,Nuts,Pig	
8S	417	112711	20:44	21:06	07-59.97S	080-29.84E	5386.0	497.8	501.3	505.1	8SM417	2011112721	-	
8S	418	112711	23:41	00:15	08-00.14S	080-29.81E	5383.0	498.5	502.2	505.6	8SM418	2011112800	DO,pH,Nuts,Pig	
8S	419	112811	02:42	03:04	08-00.23S	080-29.80E	5383.0	498.7	502.7	506.1	8SM419	2011112803	-	
8S	420	112811	05:41	06:34	07-59.92S	080-29.80E	5384.0	1003.3	1000.7	1009.3	8SM420	2011112806	DO,Sal,pH,Nuts,Pig	
5S	2	112911	06:06	06:44	05-07.70S	078-06.28E	4973.0	997.6	1000.5	1008.4	5SM002	2011112906	DO,Sal,pH,Nuts,Pig	End of Leg2 The header information was changed form '8S' to '5S'.

5.15 Salinity of sampled water

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki Katsumata	(JAMSTEC)	- Principal Investigator (Leg-2)
Fujio Kobayashi	(MWJ)	- Operator (Leg-1)
Tamami Ueno	(MWJ)	- Operator (Leg-2)

(2) Objective

To provide a calibration for the measurement of salinity of bottle water collected on the CTD casts and The Continuous Sea Surface Water Monitoring System (TSG).

(3) Method

a. Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X bottles and TSG. The salinity sample bottle of the 250ml brown glass bottle with screw cap was used for collecting the sample water. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. The sample bottle was sealed with a plastic inner cap and a screw cap ; the thimble being thoroughly rinsed before use. The bottle was stored for more than 18 hours in the laboratory before the salinity measurement.

The kind and number of samples taken are shown as follows ;

Table 5.15-1 Kind and number of samples

Kind of Samples	Number of Samples(Leg1)	Number of Samples(Leg2)
Samples for CTD	52	58
Samples for TSG	28	32
Total	80	90

b. Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR11-07 Leg1 and Leg2 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 62556) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were used. The thermometer monitored the ambient temperature and the other monitored a bath temperature.

The specifications of the 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 re-standardization

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 the 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. The ambient temperature varied from approximately 22 deg C to 24 deg C, while the bath temperature was very stable and varied within +/- 0.002 deg C on rare occasion. The measurement for each sample was done with a double conductivity ratio and defined as the median of 31 readings of the salinometer. Data collection was started 5 seconds after filling the cell with the sample and it took about 10 seconds to collect 31 readings by a personal computer. Data were taken for the sixth and seventh filling of the cell. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity with the algorithm for the practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.00003, an eighth filling of the cell was done. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity. The measurement was conducted in about 4 hours per day and the cell was cleaned with soap after the measurement of the day.

(4) Results

(4-1)Results of Leg1

a. Standard Seawater

Standardization control of the salinometer was set to 768 and all measurements were done at this setting. The value of STANDBY was 5581 +/- 0001 and that of ZERO was 0.0+0000 or 0.0+0001. The conductivity ratio of IAPSO Standard Seawater batch P153 was 0.99979 (double conductivity ratio was 1.99958) and was used as the standard for salinity. 14 bottles of P153 were measured.

Fig.5.15-1 shows the history of the double conductivity ratio of the Standard Seawater batch P153. The average of the double conductivity ratio was 1.99956 and the standard deviation was 0.00001, which is equivalent to 0.0003 in salinity.

Fig.5.15-2 shows the history of the double conductivity ratio of the Standard Seawater batch P153 after correction. The average of the double conductivity ratio after correction was 1.99958 and the standard deviation was 0.00001, which is equivalent to 0.0001 in salinity.

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

batch	:	P153
conductivity ratio	:	0.99979
salinity	:	34.992
use by	:	8th March 2014

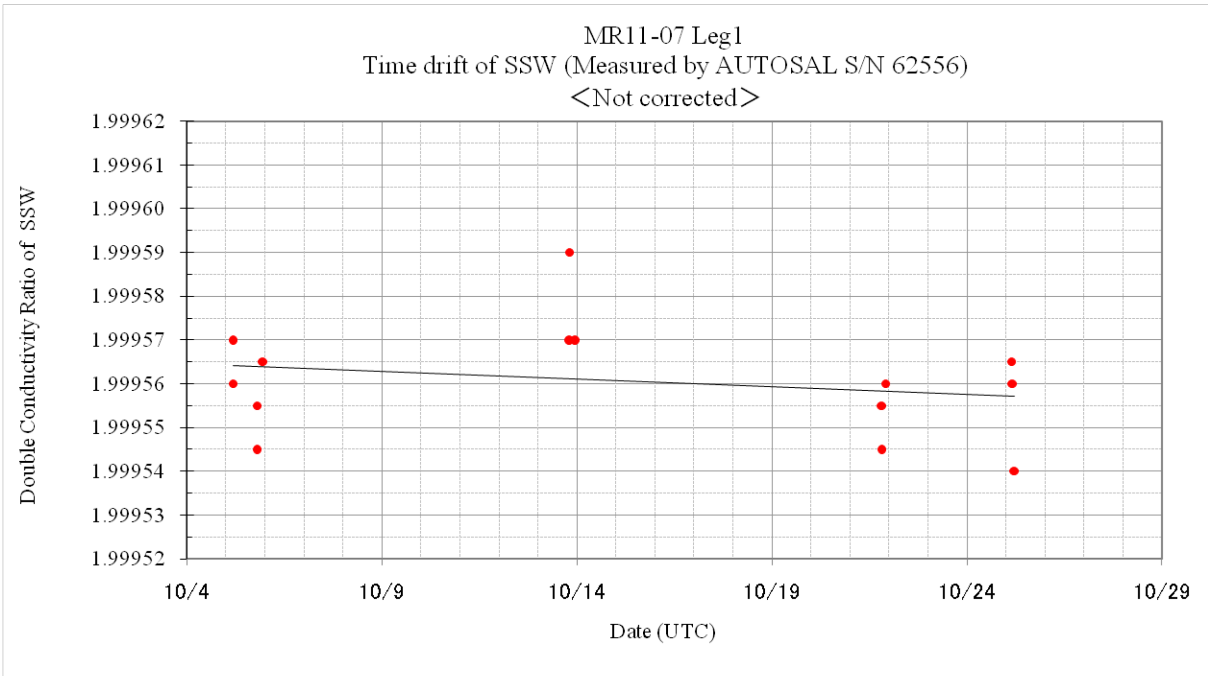


Fig. 5.15-1: History of double conductivity ratio for the Standard Seawater batch P153 (before correction)

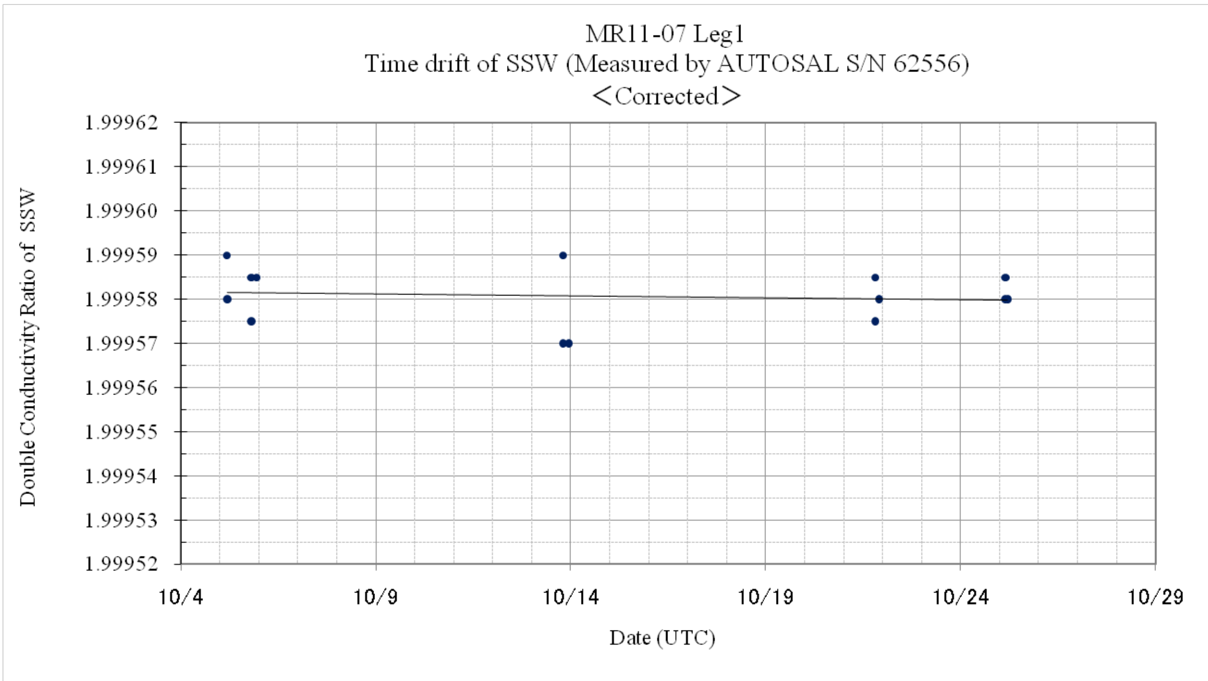


Fig. 5.15-2: History of double conductivity ratio for the Standard Seawater batch P153 (after correction)

b. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by a pore size of 0.45 micrometer and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 8 samples in order to check for the possible sudden drifts of the salinometer.

c. Replicate Samples

We estimated the precision of this method using 26 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 26 pairs of replicate samples were 0.0004 and 0.0002 in salinity, respectively.

(4-2)Results of Leg2

a. Standard Seawater

Standardization control of the salinometer was set to 768 until 11th November. During this period, the value of STANDBY was 24+5581 +/- 0001 and that of ZERO was 0.0±0000. Because of changing the standardization value from its first value, the salinometer standardization control was set again to 785 at 11th November. After the day, the value of STANDBY was 24+5594 +/- 0001 and that of ZERO was 0.0±0000. The conductivity ratio of IAPSO Standard Seawater batch P153 was 0.99979 (double conductivity ratio was 1.99958) and was used as the standard for salinity. 27 bottles of P153 were measured.

Fig.5.15-3 shows the history of the double conductivity ratio of the Standard Seawater batch P153. At first period, the average of the double conductivity ratio was 1.99955 and the standard deviation was 0.00002, which is equivalent to 0.0003 in salinity. At second period, the average of the double conductivity ratio was 1.99958 and the standard deviation was 0.00002, which is equivalent to 0.0003 in salinity.

Fig.5.15-4 shows the history of the double conductivity ratio of the Standard Seawater batch P153 after correction. At first period, the average of the double conductivity ratio after correction was 1.99958 and the standard deviation was 0.00002, which is equivalent to 0.0003 in salinity. At second period, the average of the double conductivity ratio was 1.99958 and the standard deviation was 0.00001, which is equivalent to 0.0003 in salinity.

b. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by a pore size of 0.45 micrometer and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 6 samples in order to check for the possible sudden drifts of the salinometer.

c. Replicate Samples

We estimated the precision of this method using 29 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 29 pairs of replicate samples were 0.0003 and 0.0003 in salinity, respectively.

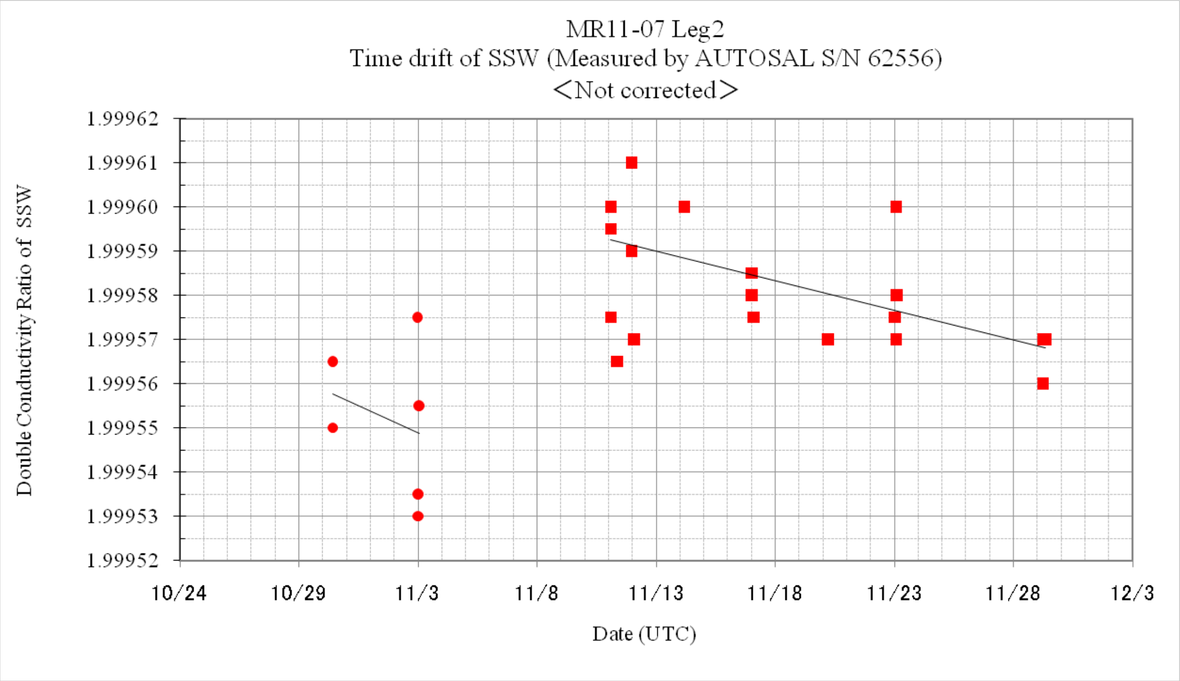


Fig. 5.15-3: History of double conductivity ratio for the Standard Seawater batch P153 (bfore correction).

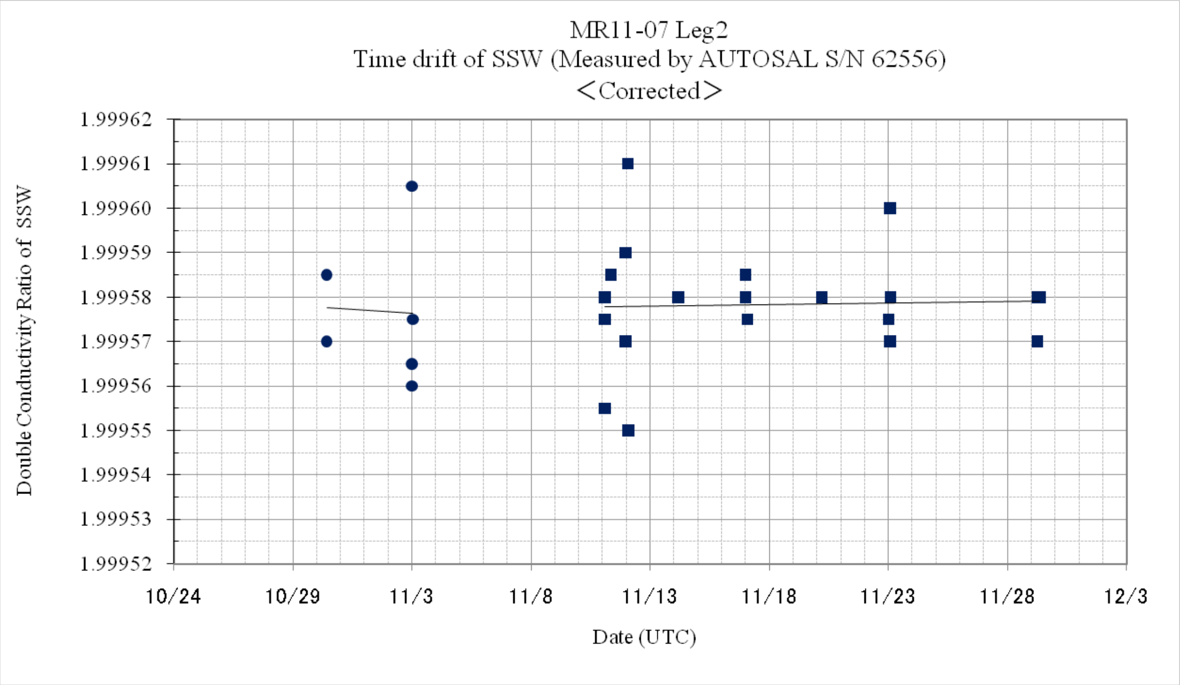


Fig. 5.15-4: History of double conductivity ratio for the Standard Seawater batch P153 (after correction)

(5) Data archive

These raw datasets will be submitted to JAMSTEC Data Management Office (DMO).

(6) Reference

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

・UNESCO : Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp., 1981

5.16 Dissolved oxygen of sampled water

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio Yoneyama*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki Katsumata***	(JAMSTEC)	- Principal Investigator (Leg-2)
Hironori Sato*	(MWJ)	- Operation Leader (Leg-1)
Kanako Yoshida*	(MWJ)	
Shinichiro Yokogawa**	(MWJ)	- Operation Leader (Leg-2)

(2) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(3) Instruments and Methods

Following procedure is based on an analytical method, entitled by “Determination of dissolved oxygen in sea water by Winkler titration”, in the WHP Operations and Methods (Dickson, 1996).

a. Instruments

Burette for sodium thiosulfate and potassium iodate:

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

Detector:

Automatic photometric titrator (DOT-01X) manufactured by Kimoto Electronic Co. Ltd.

Software:

DOT Terminal version 1.2.0

b. Reagents

Pickling Reagent I: Manganese chloride solution (3 mol dm^{-3})
Pickling Reagent II: Sodium hydroxide (8 mol dm^{-3}) / sodium iodide solution (4 mol dm^{-3})
Sulfuric acid solution (5 mol dm^{-3})
Sodium thiosulfate (0.025 mol dm^{-3})
Potassium iodide (0.001667 mol dm^{-3})
CSK standard of potassium iodide:
Lot EPJ3885, Wako Pure Chemical Industries Ltd., 0.0100N

c. Sampling

Seawater samples were collected with Niskin bottle attached to the CTD-system and surface bucket sampler. Seawater for oxygen measurement was transferred from sampler 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 and 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. 1 cm^3 sulfuric acid solution and a magnetic stirrer bar 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 2 sets of the titration apparatus. Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, CTD salinity, flask volume, and titrated volume of sodium thiosulfate solution without the blank.

e. Standardization and determination of the blank

Concentration of sodium thiosulfate titrant was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130 ^{o}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 (0.001667 mol dm^{-3}). 10 cm^3 of the standard potassium iodate solution was added to a flask using a volume-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 titrated volume of sodium thiosulfate (usually 5 times measurements average) gave the morality of sodium thiosulfate titrant.

The oxygen in the pickling reagents I (0.5 cm^3) and II (0.5 cm^3) was assumed to be 3.8 x 10^{-8} mol (Murray *et al.*, 1968). The blank due to other than oxygen was determined as follows. 1 and 2 cm^3 of the standard potassium iodate solution were added to two flasks respectively 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 each were added into the flask in order. The blank was determined by difference between the first (1 cm^3 of KIO_3) titrated volume of the sodium thiosulfate and the second (2 cm^3 of KIO_3) one. The results of 3 times blank determinations were averaged.

(4) Preliminary Results

Table 5.16-1 shows results of the standardization and the blank determination during this cruise.

Table 5.16-1: Results of the standardization and the blank determinations.

Data	KIO_3 ID	$Na_2S_2O_3$	DOT-01X(No.7)		DOT-01X(No.8)	
			E.P.	Blank	E.P.	Blank
2011/09/27	CSK	20110602-22	3.947	-0.005	3.953	0.000
2011/09/27	20110523-03-01	20110602-22	3.951	-0.005	3.956	0.000
2011/10/02	20110523-03-02	20110602-22	3.956	-0.004	3.959	0.004
2011/10/06	20110523-03-03	20110602-22	3.956	-0.003	3.960	0.003
2011/10/06	20110523-03-03	20110602-24	3.951	-0.003	3.957	0.002
2011/10/10	20110523-03-04	20110602-24	3.953	-0.002	3.958	0.004
2011/10/14	20110523-03-05	20110602-24	3.955	-0.002	3.960	0.003
2011/10/18	20110523-03-06	20110602-24	3.957	0.001	3.961	0.006
2011/10/18	20110523-03-06	20110602-25	3.953	-0.003	3.958	0.004
2011/10/22	20110523-03-07	20110602-25	3.953	-0.002	3.958	0.004
2011/10/25	20110523-03-08	20110602-25	3.953	-0.002	3.958	0.004

Table 5.16-1 (cont'd)

Data	KIO_3 ID	$Na_2S_2O_3$	DOT-01X(No.5)		DOT-01X(No.6)	
			E.P.	Blank	E.P.	Blank
2011/10/30	20110523-03-09	20110602-26	3.947	-0.003	3.953	0.001
2011/11/03	20110523-03-10	20110602-26	3.949	-0.001	3.953	0.002
2011/11/07	20110523-04-01	20110602-26	3.951	-0.002	3.955	0.004
2011/11/07	CSK	20110602-26	3.947	-0.002	3.950	0.004

Data	KIO_3 ID	$Na_2S_2O_3$	DOT-01X(No.5)		DOT-01X(No.8)	
			E.P.	Blank	E.P.	Blank
2011/11/11	20110523-04-02	20110602-26	3.952	-0.001	3.955	0.002
2011/11/15	20110523-04-03	20110602-26	3.955	-0.001	3.954	0.001
2011/11/18	20110523-04-09	20110602-26	3.959	0.002	3.959	0.002
2011/11/18	20110523-04-09	20110602-27	3.951	-0.002	3.955	0.001
2011/11/23	20110523-04-04	20110602-27	3.951	-0.003	3.955	0.002
2011/11/28	20110523-04-05	20110602-27	3.951	-0.003	3.955	0.000

f. Repeatability of sample measurement

Replicate samples were taken at every CTD casts. Total amount of the replicate sample pairs of good measurement was 413. The standard deviation of the replicate measurement was 0.15 μmol kg^{-1} that was calculated by a procedure in Guide to best practices for ocean CO_2 measurements Chapter4 SOP23 Ver.3.0 (2007).

(5) Data archive

All raw datasets will be submitted to JAMSTEC Data Management Office (DMO).

(6) References

Dickson, A.G., Determination of dissolved oxygen in sea water by Winkler titration. (1996)
Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.), Guide to best practices for ocean CO2 measurements. (2007)
Culberson, C.H., WHP Operations and Methods July-1991 "Dissolved Oxygen", (1991)
Japan Meteorological Agency, Oceanographic research guidelines(Part 1). (1999)
KIMOTO electric CO. LTD., Automatic photometric titrator DOT-01X Instruction manual

5.17 Nutrients of sampled water

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio Yoneyama*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki Katsumata***	(JAMSTEC)	- Principal Investigator (Leg-2)
Masanori Enoki*	(MWJ)	- Operator (Leg-1)
Yasuhiro Arii**	(MWJ)	- Operator (Leg-2)

(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 BL-Tech QUAATRO system. The laboratory temperature was maintained between 23-25 deg C.

The analytical methods of the nutrients, nitrate, nitrite, silicate and phosphate, during this cruise were same as the methods used in Kawano et al. (2009).

a. Measured Parameters

Nitrate + nitrite and nitrite were analyzed according to the modification method of Grasshoff (1970). The sample nitrate was reduced to nitrite in a cadmium tube inside of which was coated with metallic copper. The sample streamed with its equivalent nitrite was treated with an acidic, sulfanilamide reagent and the nitrite forms nitrous acid which reacted with the sulfanilamide to produce a diazonium ion. N-1-Naphthylethylene-diamine added to the sample stream then coupled with the diazonium ion to produce a red, azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite reacted and were measured; without reduction, only nitrite reacted. Thus, for the nitrite analysis, no reduction was performed and the alkaline buffer was not necessary. Nitrate was computed by difference.

Absorbance of 550 nm by azo dye in analysis is measured using a 1 cm length cell for nitrate and 3 cm length cell for nitrite.

The silicate method was analogous to that described for phosphate. The method used was essentially that of Grasshoff et al. (1983), wherein silicomolybdic acid was first formed from the silicate in the sample and added molybdic acid; then the silicomolybdic acid was reduced to silicomolybdous acid, or "molybdenum blue" using ascorbic acid as the reductant.

Absorbance of 630 nm by silicomolybdous acid in analysis is measured using a 1 cm length cell.

The phosphate analysis was a modification of the procedure of Murphy and Riley (1962). Molybdic acid was added to the seawater sample to form phosphomolybdic acid which was 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 1 cm length cell.

b. Nutrients Standard

Specifications

For nitrate standard, “potassium nitrate 99.995 Suprapur®” provided by Merck, CAS No.: 7757-91-1, was used.

For nitrite standard, “sodium nitrate” provided by Wako, CAS No.: 7632-00-0, was used. The assay of nitrite salts was determined according JIS K8019 were 98.31%. We used that value to adjust the weights taken.

For phosphate standard, “potassium dihydrogen phosphate anhydrous 99.995 Suprapur®” provided by Merck, CAS No.: 7778-77-0, was used.

For the silicate standard, we use “Silicon standard solution SiO_2 in NaOH 0.5 mol/l CertiPUR®” provided by Merck, CAS No.: 1310-73-2, of which lot number HC097572 was used. The silicate concentration was certified by NIST-SRM3150 with the uncertainty of 0.5 %. Factor of HC097572 was signed 1.000, however we reassigned the factor as 0.976 from the result of comparison among HC074650 and RMNS in MR11-E02 cruise.

Ultra pure water (Milli-Q) freshly drawn was used for preparation of reagent, standard solutions and for measurement of reagent and system blanks.

Concentrations of nutrients for A, B and C standards

Concentrations of nutrients for A, B and C standards (working standards) were set as shown in Table 5.17.1 Then the actual concentration of nutrients in each fresh standard was calculated based on the ambient temperature, solution temperature and determined factors of volumetric laboratory wares.

The calibration curves for each run were obtained using 4 levels working standards, C-1, C-2, C-3, and C-4.

Table 5.17.1 Nominal concentrations of nutrients for A, B and C standards.

	A	B	C-1	C-2	C-3	C-4
Nitrate (μmol/l)	22000	900	0.05	9.4	28.1	46.9
Nitrite (μmol/l)	4000	40	0.01	0.4	1.2(0.8)	1.9(1.6)
Silicate (μmol/l)	36000	1385	1.39	15.2	42.8	70.6
Phosphate (μmol/l)	3000	60	0.05	0.7	1.8	3.1

Value in parentheses was used to calibration curve for Cast 001-017.

c. Sampling Procedures

Sampling of nutrients followed that oxygen and pH. Samples were drawn into two of virgin 10 ml polyacrylates vials without sample drawing tubes. These were rinsed three times before filling and vials were capped immediately after the drawing. The vials were put into water bath adjusted to ambient temperature, 24 ± 1 deg. C, in about 30 minutes before use to stabilize the temperature of samples. The samples of bottle 15, 21 and 20 (or 19) were measured in replicate and the rest were measured in single on each sample run.

No transfer was made and the vials were set an auto sampler tray directly. Samples were analyzed after collection basically within 24 hours.

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 10 - 12 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., Lot BT), for every 3 runs to secure comparability on nutrient analysis throughout the cruise. We used same serial RMNS for 6 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 was stored in 20 liter cubitainer with paper box. The concentrations of nutrient of this water were measured carefully in January 2011.

(4) Results

Analytical precisions in this cruise Leg1 were 0.14% for nitrate, 0.22% for nitrite, 0.15% for silicate, 0.25% for phosphate in terms of median of precision, respectively. Analytical precisions in Leg2 were 0.09% for nitrate, 0.11% for nitrite, 0.11% for silicate, 0.17% for phosphate in terms of median of precision, respectively. Results of analytical precisions for nitrate, nitrite, silicate and phosphate are shown in Table 5.17.4.1 and Table 5.17.4.2 for the cast's comparability.

Results of RMNS analysis are shown in Table 5.17.4.3 and Table 5.17.4.4 for the cast's comparability.

Table 5.17.4.1 Summary of precision based on the analyses at Leg1.

	Nitrate CV %	Nitrite CV %	Silicate CV %	Phosphate CV %
Median	0.14	0.22	0.15	0.25
Mean	0.14	0.22	0.14	0.26
Maximum	0.27	0.45	0.23	0.53
Minimum	0.06	0.07	0.04	0.06
N	26	26	26	26

Table 5.17.4.2 Summary of precision based on the analyses at Leg2.

	Nitrate CV %	Nitrite CV %	Silicate CV %	Phosphate CV %
Median	0.09	0.11	0.11	0.17
Mean	0.10	0.11	0.10	0.16
Maximum	0.20	0.22	0.18	0.26
Minimum	0.03	0.04	0.02	0.07
N	29	29	29	29

Table 5.17.4.3 Results of RMNS Lot BT analysis in this cruise Leg1.

Date(UTC)	Serial	Cast	Nitrate (μmol/kg)	Nitrite (μmol/kg)	Silicate (μmol/kg)	Phosphate (μmol/kg)
30 Sep	1977	001	18.20	0.46	40.65	1.319
1 Oct	1364	003,005	18.12	0.45	40.85	1.321
1 Oct	1364	007,009	18.19	0.46	40.98	1.292
2 Oct	1364	011,013,015,017	18.22	0.46	40.96	1.310
3 Oct	1364	019,021,023,025	18.22	0.45	40.95	1.308
4 Oct	510	027,029,031,033	18.27	0.46	41.11	1.322
5 Oct	510	035,037,039,041	18.15	0.46	40.70	1.303
6 Oct	510	043,045,047,049	18.23	0.47	40.94	1.321
7 Oct	789	051,053,055,057	18.22	0.46	41.02	1.319
8 Oct	789	059,061,063,065	18.24	0.46	40.75	1.321
9 Oct	789	067,069,071,073	18.20	0.46	40.80	1.304
10 Oct	1314	075,077,079,081	18.21	0.46	40.99	1.318
11 Oct	1314	083,085,087,089	18.24	0.46	40.92	1.314
12 Oct	1314	091,093,095,097	18.20	0.46	40.93	1.317
13 Oct	1035	099,101,103,105	18.17	0.48	40.96	1.319
14 Oct	1035	107,109.111.113	18.19	0.47	40.83	1.341
15 Oct	1035	115,117,119,121	18.35	0.45	41.05	1.320
16 Oct	252	123,125,127,129	18.25	0.46	40.83	1.331
17 Oct	252	131,133,135,137	18.19	0.47	40.72	1.346
18 Oct	252	139,141,143,145	18.17	0.47	40.77	1.345
19 Oct	716	147,149,151,153	18.18	0.46	40.82	1.351
20 Oct	716	155,157,159,161	18.21	0.48	40.67	1.329
21 Oct	716	163,165,167,169	18.16	0.47	40.51	1.300
22 Oct	1879	171,173,175,177	18.17	0.47	40.72	1.312
23 Oct	1879	179,181,183,185	18.20	0.46	40.85	1.309
24 Oct	1879	187,189,191,193	18.42	0.46	40.62	1.312
		Median S.D.	18.20 ±0.08	0.46 ±0.01	40.83 ±0.15	1.319 ±0.014

Table 5.17.4.4 Results of RMNS Lot BT analysis in this cruise Leg2.

Date(UTC)	Serial	Cast	Nitrate (μmol/kg)	Nitrite (μmol/kg)	Silicate (μmol/kg)	Phosphate (μmol/kg)
31 Oct	739	194,196	18.11	0.46	40.58	1.314
1 Nov	739	198,200,202,204	18.19	0.46	40.85	1.333
2 Nov	739	206,208,210,212	18.18	0.46	40.81	1.315
3 Nov	1080	214,216,218,220	18.19	0.45	40.77	1.315
4 Nov	1080	222,224,226,228	18.22	0.46	40.81	1.319
5 Nov	1080	230,232,234,236	18.25	0.46	40.84	1.319
6 Nov	1532	238,240,242,244	18.23	0.46	41.00	1.318
7 Nov	1532	246,248,250,252	18.24	0.45	40.81	1.325
8 Nov	1532	254,256,258,260	18.23	0.45	40.83	1.319
9 Nov	1429	262,264,266,268	18.26	0.45	40.78	1.333
10 Nov	1429	270,272,274,276	18.26	0.46	40.86	1.332
11 Nov	1429	278,280,282,284	18.25	0.47	41.06	1.322
12 Nov	1629	286,288,290,292	18.24	0.46	40.83	1.313
13 Nov	1629	294,296,298,300	18.16	0.46	40.84	1.310
14 Nov	1629	302,304,306,308	18.16	0.46	40.73	1.297
15 Nov	1018	310,312,314,316	18.27	0.46	41.01	1.316
16 Nov	1018	318,320,322,324	18.24	0.46	40.83	1.327
17 Nov	1018	326,328,330,332	18.18	0.46	40.66	1.328
18 Nov	0877	334,336,338,340	18.09	0.46	40.60	1.320
19 Nov	0877	342,344,346,348	18.32	0.46	40.91	1.328
20 Nov	0877	350,352,354,356	18.26	0.47	40.90	1.324
21 Nov	0430	358,360,362,364	18.29	0.46	40.93	1.329
22 Nov	0430	366,368,370,372	18.21	0.47	40.75	1.323
23 Nov	0430	374,376,378,380	18.30	0.46	40.88	1.326
24 Nov	0440	382,384,386,388	18.28	0.47	40.91	1.337
25 Nov	0440	390,392,394,396	18.29	0.47	40.93	1.332
26 Nov	0440	398,400,402,404	18.33	0.47	40.95	1.316
27 Nov	0491	406,408,410,412	18.29	0.46	40.93	1.332
28 Nov	0491	414,416,418,420	18.20	0.45	40.96	1.328
		Median	18.24	0.46	40.84	1.323
		S.D.	±0.06	±0.01	±0.11	±0.009

(5) Data Archive

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

(6) Reference

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.

Kawano, T., Uchida, H. and Doi, T. WHP P01, P14 REVISIT DATA BOOK, (Ryoin Co., Ltd., Yokohama, 2009).

Murphy, J., and Riley, J.P. (1962), Analytica chim. Acta 27, 31-36.

5.18 Chlorophyll *a* of sampled water

(1) Personal (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio Yoneyama*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki Katsumata***	(JAMSTEC)	- Principal Investigator (Leg-2)
Masahiro Orui*	(MWJ)	- Operation leader (Leg-1)
Hironori Sato*	(MWJ)	
Kanako Yoshida*	(MWJ)	
Satoshi Ozawa*	(MWJ)	
Shinsuke Toyoda*	(MWJ)	
Shungo Oshitani*	(MWJ)	
Yuuki Miyajima*	(MWJ)	
Miyo Ikeda**	(MWJ)	- Operation leader (Leg-2)
Shinichiro Yokogawa**	(MWJ)	

(2) Objectives

We measured total chlorophyll *a* in seawater by using the fluorometric method.

(3) Instruments and Methods

(a) Reagents

Standard; chlorophyll *a* standard (SIGMA-ALDRICH Japan K.K.)

Extraction and dilution solutions; N,N-dimethylformamide
(Wako Pure chemical Industries, Ltd.)

Acidification reagent; 1.0 M HCl (Wako Pure chemical Industries, Ltd.)

(b) Instruments

Spectorophotometer: UV-2400PC, manufactured by SHIMADZU CORPORATION

Fluorometer : 10-AU-005 manufactured by Turner Designs

Analytical condition was listed in table 5.18-1.

(c) Method

Acidification method (Holm-Hansen *et al.*, 1965)

(4) Sampling

Following procedure is based on “Fluorometric determination of chlorophyll” (Holm-Hansen *et al.*, 1965). We collected samples from 10 - 12 depths between the surface and 500 m with bucket and Niskin bottles attached to the CTD-system.

Water samples were transferred to shading Nalgene bottles (ca. 500 cm^3) from bucket and Niskin bottles. After sampling, water samples were vacuum-filtrated (<0.02MPa) through 25mm-diameter Whatman GF/F filter. Phytoplankton pigments retained on the filters were immediately extracted in a polypropylene tube with 7 ml of N,N-dimethylformamide. The tubes were stored at –20°C under the dark condition to extract chlorophyll *a* for 24 hours or more.

(5) Standardization

The fluorometer was calibrated with a chlorophyll *a* standard in each cruise. The chlorophyll *a* standard concentration was determined by spectorophotometer. We prepared 9 dilutions from the chlorophyll *a* standard. Dilutions measuring with the fluorometer were taken before (F_o) and after acidification (F_a) with 2 drops 1.0 M HCl. We calculated linear calibration factor (K_x) and the acidification coefficient (F_m) from dilutions measurement data. The blank of DMF also measured with the fluorometer. The Blank value was subtracted from F_o and F_a.

(6) Sample measurement

Following extraction, samples were removed from freezer in the dark room and the fluorometer was allowed to warm up and stabilize for 1 hour prior to measure. We measured Working Standard solution (ca. 20-30 ug/L) and DMF blank each 10 - 15 samples. Working Standard solution was measured for corrected K_x and F_m. All samples were measured on board.

(7) Repeatability of sample measurement

During this cruise we measured Total chlorophyll *a* concentration in 2415 seawater samples at 211 casts. Replicate samples were taken at every CTD casts. The relative standard deviation of the replicate measurement was shown the table 5.18-2.

(8) Preliminary Results

The result of total chlorophyll *a* was shown as the vertical distribution (Figure 5-18).

(9) Data archive

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

(10) Reference

(1) 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.

(2) SHIMADZU CORPORATION 1996. UV-2400PC Instruction manual

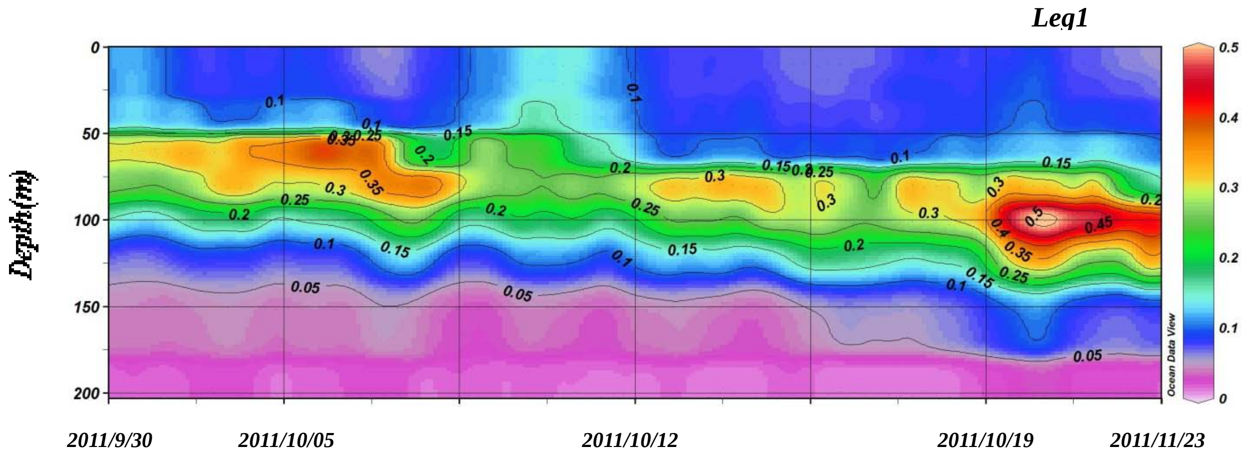
(3) TURNER Designs 1992. MODEL 10-AU-005 LABORATORY FIELD FLUOROMETER USER’S MANUAL

Table 5.18-1: Analytical conditions of “Acidification method” for chlorophyll *a* with Turner Designs fluorometer (10-AU-005)

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

Table 5.18-2: Repeatability of sample measurement

Leg	Leg1	Leg2
Number of replicate samples	97	114
R.S.D. (%)	4.8	3.2



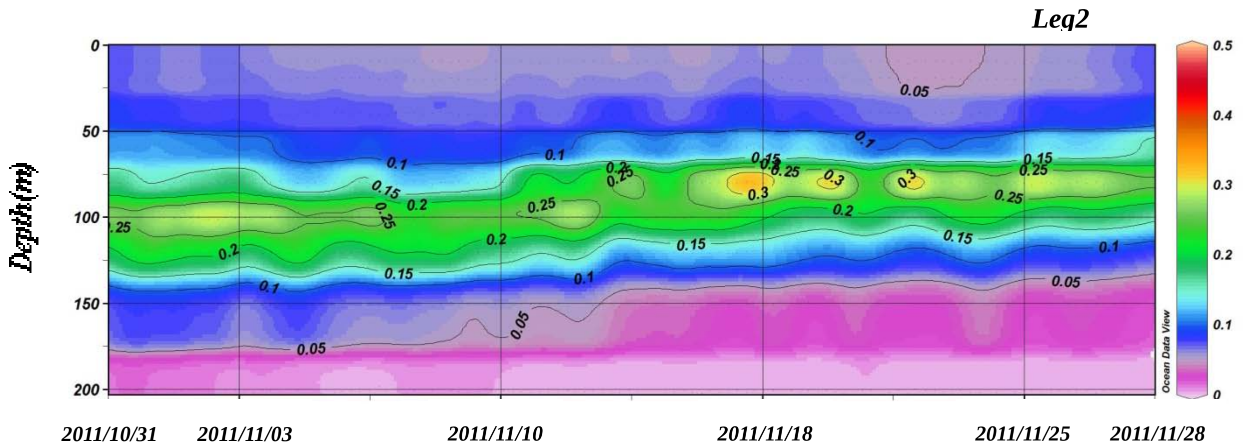


Figure 5.18-1: Vertical distribution of chlorophyll *a* concentration (μg/L) at Stn.8S in this cruise.

5.19 pH of sampled water

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio Yoneyama*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki Katsumata***	(JAMSTEC)	- Principal Investigator (Leg-2)
Ayaka Hatsuyama*	(MWJ)	- Operation leader (Leg-1)
Hironori Satoh*	(MWJ)	
Kanako Yoshida*	(MWJ)	
Makoto Takada**	(MWJ)	- Operation leader (Leg-2)
Minoru Kamata**	(MWJ)	

(2) Objective

In order to solve the mechanism of the Madden-Julian Oscillation (MJO) development, the vertical distribution of salinity, dissolved oxygen, nutrients, Chlorophyll-a and pH were measured in the equatorial Indian Ocean. We here report on board measurements of pH during MR11-07 cruise.

(3) Methods, Apparatus and Performance

(3)-1 Seawater sampling

Seawater samples were collected by 12 liter Niskin bottles mounted on the CTD/Carousel Water Sampling System and a bucket. Seawater was sampled in a 100 ml 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 ultrapure water for 3 times. A sampling silicone rubber tube with PFA tip was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom smoothly, without rinsing, and were overflowed for 2 times bottle volume (about 10 seconds) with care not to leave any bubbles in the bottle. The water in the bottle was sealed by a glass made cap gravimetrically fitted to the bottle mouth without additional force. After collecting the samples on the deck, the bottles were carried into the lab and put in the water bath kept about 25 deg C before the measurement.

(3)-2 Seawater analyses

pH (-log[H^+]) of the seawater was measured potentiometrically in the glass bottles. The pH / Ion meter (Radiometer PHM240) is used to measure the electromotive force (e.m.f.) between the glass electrode cell (Radiometer pHG201) and the reference electrode cell (Radiometer REF201) in the sample with its temperature controlled to 25 +/- 0.05 deg C.

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

To calibrate the electrodes, the TRIS buffer (Lot=110525, 100715: pH=8.0910, 8.0906 pH units at 25 deg C, Delvalls and Dickson, 1998) and AMP buffer (Lot=110526, 100720: pH=6.7845, 6.7838 pH units at 25 deg C, DOE, 1994) in the synthetic seawater (Total hydrogen ion concentration scale) were applied. pH_T of seawater sample (pH_{spl}) is calculated from the expression:

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

where electrode response ER is calculated as follows:

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

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

$$ER = RT\ LN(10) / F = 59.16 \text{ mV / pH units at 25 deg C}$$

(4) Preliminary results

A replicate analysis of seawater sample was made at 2 layers (ex. 80 and 200 m depth) of cast. The difference between each pair of analyses was plotted on a range control chart (see Figure 5.19-1). The average of the difference was 0.001 pH units (n = 396 pairs) with its standard deviation of 0.001 pH units. These values were lower than the value recommended by Guide (Dickson et al., 2007).

(5) Data Archive

All data will be submitted to JAMSTEC and is currently under its control.

(6) Reference

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 ResearchⅠ 45, 1541-1554.

Dickson, A. G., C. L. Sabine and J. R. Christian, Eds. (2007): Guide to best practices for ocean CO_2 measurements, PICES Special Publication 3, 199pp.

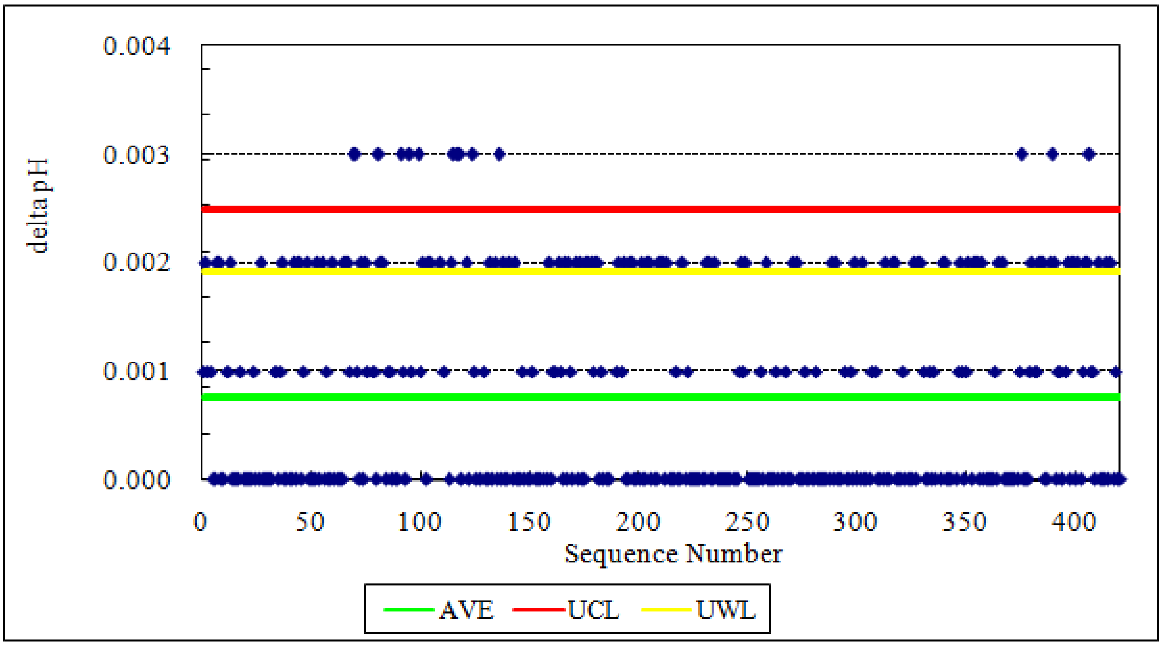


Figure 5.19-1: Range control chart of the absolute differences of replicate measurements of pH carried out during the cruise. AVE represents the average value, UCL upper control limit (UCL = AVE * 3.267), and UWL upper warning limit (UWL = AVE * 2.512) (Dickson et al., 2007).

5.20 Micro structure profiler for the ocean

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio YONEYAMA*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki KATSUMATA***	(JAMSTEC)	- Principal Investigator (Leg-2)
Kazuaki YASUNAGA**	(JAMSTEC)	
Ayako SEIKI**	(JAMSTEC)	
Chiharu TAKAHASHI*	(JAMSTEC)	
Momoko KIMURA**	(JAMSTEC)	
Kelvin RICHARDS*	(IPRC)	
Andrei NATAROV***	(IPRC)	
Souichiro SUEYOSHI***	(GODI)	- Operation Leader (Leg-1 and 2)
Asuka DOI***	(GODI)	
Toshimitsu GOTO***	(GODI)	
Katsuaki MAENO *	(GODI)	
Ryo KIMURA*	(GODI)	
Satoshi OKUMURA**	(GODI)	
Kazuho YOSHIDA**	(GODI)	
Wataru TOKUNAGA***	(MIRAI Crew)	

(2) Objectives

To obtain oceanic vertical profiles of the dissipation rate of turbulent kinematic energy, as well as dissipation rate of temperature variance, turbulent mixing rate of substances, etc.

(3) Methods

The instrument in this observation consists of sensor unit “TurboMAP-L” (manufactured by JFE Advantech Inc., serial no. 34) and the software “TMtools” (ver. 3.04D) on PC to monitor, record and process the data. The probes on the TurboMAP sensor unit are as follows:

- Vertical shear of the horizontal current speed (two sensors, 512 Hz)
- Fast thermistor temperature “FPO-7” (512Hz)
- Slow response temperature (64Hz)
- Conductivity (64Hz)
- Pressure (64Hz)
- Acceleration in X, Y and Z dimensions (256Hz for horizontal, 64Hz for vertical)
- Fluorescence (256Hz) (*see (6)Remarks)
- Turbidity (256Hz)

These parameters were obtained during the sensor descends without artificial accelerations (i.e. “free fall”). The obtained data was monitored and stored in the PC on the vessel in real-time.

The instruments were operated to obtain profiles down to 300m depth (see (6) Remarks for exceptions). To do it by minimized time consumption, the cable between PC and the sensor unit were deployed until the sensor unit reached 260-m depth, and then started winding up when sensor reached 300-m depth. The data was recorded until the sensor stopped its free-fall (i.e. falling speed start decreasing).

All profiles were obtained at (8S, 80.5E). The observations were carried out every 3 hours thru the stationary observation periods (Leg-1 from 06UTC on Sep.30 to 06UTC on Oct. 24, and Leg-2 from 00UTC on Oct.31 to 06UTC on Nov.28). In one 3-hourly cycle, two profiles were obtained sequentially, while one or several profiles were obtained occasionally. As in Table 5.20-1, 874 profiles were obtained in total during the present cruise.

(4) Preliminary Results

Figures 5.20-1 and 5.20-2 are the time-depth cross section of the dissipation rate of kinematic energy (epsilon). The high epsilon value could be found in the surface mixing layer with significant diurnal cycle. The further detailed analyses will be in near future.

(5) Data archive

All data during this cruise will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG). The corrected datasets will be available at CINDY website.

(6) Remarks

a) Some of the profiles did not reach 300-m depth. From 06UTC on Oct.16 to 09UTC on Oct.17, the target minimum depth was set as 200 m, due to temporal change of operation policy. Besides, the sensor did not reached 300-m depth in several profiles because of too short length of wire deployment.

b) The following profiles (as shaded in Table 5.20-1) are not valid, due to error on the instruments, due to error on the operations, or due to crash of the probes:

Nos. 163, 170, 172, 352, 353, 832,

c) Data from fluorescence sensor is not valid after 21UTC on Oct.05. After the time, the sensor was covered by black tape to prevent the light going out. This was to reduce the risk of accidents due to oceanic creatures which may attracted by the light from the fluorescence sensor.

e) Most of the data from the fast thermistor temperature "FPO-7" are not valid in Leg-1 (on and before Oct.24). This is due to problem on the probe. The problem was cleared in Leg-2 (From Oct.30) by using new sensors.

f) Data from shear sensor(s) may be noisy, especially in Leg-2. The more noisy sensor was mounted as secondary sensor, while some exceptions.

Table 5.20-1: List for the MSP profiling.

No.	Nominal Time (UTC)		Logging Time		Depth observed [m]	Wire Deployed [m]	Sensor S/N		
	Date	Hour	Start	Stop			FPO7	Shear 1	Shear 2
01	2011/09/30	06Z	6:45	6:58	381	520	180	686	687
02	2011/09/30	09Z	9:03	9:14	367	450	200	686	687
03	2011/09/30	12Z	12:22	12:33	307	370	200	686	687
04	2011/09/30	15Z	15:05	15:16	341	N/A	194	686	687
05	2011/09/30	18Z	18:26	18:36	359	480	194	686	687
06	2011/09/30	21Z	21:03	21:12	320	420	194	686	687
07	2011/10/01	00Z	0:23	0:34	368	480	194	686	687
08	2011/10/01	03Z	3:06	3:06	341	470	194	686	687
09	2011/10/01	06Z	6:42	6:51	341	420	194	686	687
10	2011/10/01	06Z	6:59	7:09	338	470	194	686	687
11	2011/10/01	09Z	9:25	9:34	334	480	194	686	687
12	2011/10/01	09Z	9:25	9:34	334	480	194	686	687
13	2011/10/01	12Z	12:32	12:43	335	450	194	686	687
14	2011/10/01	12Z	12:51	13:01	353	500	194	686	687
15	2011/10/01	15Z	15:13	15:23	342	480	194	686	687
16	2011/10/01	15Z	15:30	15:39	343	440	194	686	687
17	2011/10/01	18Z	18:29	18:40	378	460	194	686	687
18	2011/10/01	18Z	18:47	N/A	338	400	194	686	687
19	2011/10/01	21Z	21:10	21:20	362	460	194	686	687

20	2011/10/01	21Z	21:27	21:36	328	430	194	686	687
21	2011/10/02	00Z	0:27	0:37	345	430	194	686	687
22	2011/10/02	00Z	0:43	0:54	308	520	194	686	687
23	2011/10/02	03Z	3:15	3:26	356	470	194	686	687
24	2011/10/02	03Z	3:33	3:43	348	450	194	686	687
25	2011/10/02	06Z	6:37	6:48	380	470	194	686	687
26	2011/10/02	06Z	7:04	7:18	380	455	194	686	687
27	2011/10/02	09Z	9:12	9:21	357	460	194	686	687
28	2011/10/02	09Z	9:31	9:41	351	460	194	686	687
29	2011/10/02	12Z	12:25	12:36	372	480	194	686	687
30	2011/10/02	12Z	12:44	12:54	355	450	194	686	687
31	2011/10/02	15Z	15:13	15:23	324	430	194	686	687
32	2011/10/02	15Z	15:29	15:38	336	460	194	686	687
33	2011/10/02	18Z	18:28	18:39	368	460	194	686	687
34	2011/10/02	18Z	18:45	18:55	347	450	194	686	687
35	2011/10/02	21Z	21:10	21:20	321	440	194	686	687
36	2011/10/02	21Z	21:27	9:37	352	450	194	686	687
37	2011/10/03	00Z	0:30	0:40	351	470	194	686	687
38	2011/10/03	00Z	0:48	0:58	355	470	194	686	687
39	2011/10/03	03Z	3:11	3:21	342	470	194	686	687
40	2011/10/03	03Z	3:29	3:38	333	440	194	686	687
41	2011/10/03	06Z	6:38	6:48	320	470	194	686	687
42	2011/10/03	06Z	6:56	7:06	321	470	194	686	687
43	2011/10/03	09Z	9:08	9:17	323	520	194	686	687
44	2011/10/03	09Z	9:29	9:38	325	500	194	686	687
45	2011/10/03	12Z	12:27	12:38	351	500	194	686	687
46	2011/10/03	12Z	12:45	12:55	351	460	194	686	687
47	2011/10/03	15Z	15:14	15:24	325	450	194	686	687
48	2011/10/03	15Z	15:31	15:39	320	430	194	686	687
49	2011/10/03	18Z	18:24	18:35	332	480	194	686	687
50	2011/10/03	18Z	18:43	18:52	332	450	194	686	687
51	2011/10/03	21Z	21:11	21:22	329	450	194	686	687
52	2011/10/03	21Z	21:29	21:38	333	430	194	686	687
53	2011/10/04	00Z	0:26	0:37	352	440	194	686	687
54	2011/10/04	00Z	0:45	0:55	349	455	194	686	687
55	2011/10/04	03Z	3:10	3:19	312	440	194	686	687
56	2011/10/04	03Z	3:27	3:36	349	480	194	686	687
57	2011/10/04	06Z	6:41	6:51	346	480	194	686	687
58	2011/10/04	06Z	6:59	7:09	342	490	194	686	687
59	2011/10/04	09Z	9:10	9:20	334	440	194	686	687
60	2011/10/04	09Z	9:29	9:38	352	450	194	686	687
61	2011/10/04	12Z	12:22	12:33	329	440	194	686	687
62	2011/10/04	12Z	12:41	12:51	354	470	194	686	687
63	2011/10/04	15Z	15:09	15:19	329	440	194	686	687
64	2011/10/04	15Z	15:25	15:33	334	440	194	686	687
65	2011/10/04	18Z	18:24	18:34	339	440	194	686	687
66	2011/10/04	18Z	18:42	18:51	334	460	194	686	687
67	2011/10/04	21Z	21:21	21:33	338	460	194	686	687
68	2011/10/04	21Z	21:40	21:49	333	430	194	686	687
69	2011/10/05	00Z	0:25	0:36	405	450	194	686	687
70	2011/10/05	00Z	0:46	0:55	338	440	194	686	687
71	2011/10/05	03Z	3:10	3:21	339	441	194	686	687
72	2011/10/05	03Z	3:30	3:43	415	556	194	686	687
73	2011/10/05	06Z	6:39	6:50	355	460	194	686	687
74	2011/10/05	06Z	6:58	7:08	359	450	194	686	687
75	2011/10/05	09Z	9:16	9:18	342	500	194	686	687
76	2011/10/05	09Z	9:27	9:36	334	450	194	686	687
77	2011/10/05	12Z	12:24	12:35	355	500	194	686	687
78	2011/10/05	12Z	12:42	12:52	334	450	194	686	687
79	2011/10/05	12Z	13:02	13:06	123	150	194	686	687
80	2011/10/05	15Z	15:11	15:22	364	470	200	686	687
81	2011/10/05	15Z	15:29	15:38	348	450	200	686	687
82	2011/10/05	18Z	18:22	18:33	337	450	200	686	687
83	2011/10/05	18Z	18:43	18:54	355	450	200	686	687
84	2011/10/05	21Z	21:10	21:20	340	450	180	770	771
85	2011/10/06	21Z	21:28	21:37	342	460	180	770	771
86	2011/10/06	00Z	0:26	0:36	333	470	180	770	771
87	2011/10/06	00Z	0:43	0:52	335	430	180	770	771
88	2011/10/06	03Z	3:11	3:21	336	470	180	770	771
89	2011/10/06	03Z	3:29	3:37	327	470	180	770	771
90	2011/10/06	06Z	6:43	6:53	318	480	180	770	771
91	2011/10/06	06Z	7:01	7:11	331	505	180	770	771
92	2011/10/06	09Z	9:09	9:18	304	530	180	770	771
93	2011/10/06	09Z	9:31	9:40	321	560	180	770	771
94	2011/10/06	12Z	12:21	12:34	367	520	180	770	771
95	2011/10/06	12Z	12:43	12:55	368	550	180	770	771
96	2011/10/06	15Z	15:09	15:19	318	480	180	770	771

97	2011/10/06	15Z	15:27	15:36	335	500	180	770	771
98	2011/10/06	18Z	18:21	18:36	347	500	180	770	771
99	2011/10/06	18Z	18:42	18:51	334	460	180	770	771
100	2011/10/06	21Z	21:10	21:20	307	510	180	770	771
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103	2011/10/07	00Z	0:43	0:52	342	470	180	770	771
104	2011/10/07	03Z	3:09	3:20	332	450	180	770	771
105	2011/10/07	03Z	3:26	3:35	325	N/A	180	770	771
106	2011/10/07	06Z	6:39	6:50	349	480	180	770	771
107	2011/10/07	06Z	6:57	7:07	359	470	180	770	771
108	2011/10/07	09Z	9:09	9:19	327	520	180	770	771
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110	2011/10/07	12Z	12:21	12:31	350	500	180	770	771
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113	2011/10/07	15Z	15:24	15:34	355	450	180	770	771
114	2011/10/07	18Z	18:22	18:32	334	450	180	770	771
115	2011/10/07	18Z	18:40	18:50	344	460	180	770	771
116	2011/10/07	21Z	21:01	21:11	344	450	180	770	771
117	2011/10/07	21Z	21:18	21:27	341	450	180	770	771
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133	2011/10/08	21Z	21:26	21:35	330	430	180	770	771
134	2011/10/09	00Z	0:23	0:33	351	420	180	770	771
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136	2011/10/09	03Z	3:08	3:18	350	440	180	770	771
137	2011/10/09	03Z	3:25	3:34	311	470	180	770	771
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157	2011/10/10	09Z	9:28	9:38	347	490	194	770	771
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165	2011/10/10	21Z	21:17	21:20	334	450	194	770	771
166	2011/10/10	21Z	21:28	21:37	342	440	194	770	771
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168	2011/10/11	00Z	0:41	0:50	336	410	194	770	771
169	2011/10/11	03Z	3:12	3:22	330	470	194	770	771
170	2011/10/11	03Z	N/A	N/A	N/A	N/A	194	770	771
171	2011/10/11	06Z	6:38	6:48	338	450	194	770	771
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173	2011/10/11	12Z	12:28	12:39	335	430	194	770	771

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175	2011/10/11	15Z	15:11	15:23	372	440	194	770	771
176	2011/10/11	15Z	15:31	15:40	374	410	194	770	771
177	2011/10/11	18Z	18:23	18:33	339	380	194	770	771
178	2011/10/11	18Z	18:43	18:52	331	400	194	770	771
179	2011/10/11	21Z	21:09	21:18	337	390	194	770	771
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181	2011/10/12	00Z	0:28	0:38	350	380	194	770	771
182	2011/10/12	00Z	0:46	0:55	312	360	194	770	771
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189	2011/10/12	12Z	12:22	12:31	316	420	194	770	771
190	2011/10/12	12Z	12:40	12:49	328	405	194	770	771
191	2011/10/12	15Z	15:09	15:20	341	410	194	770	771
192	2011/10/12	15Z	15:29	15:36	331	400	194	770	771
193	2011/10/12	18Z	18:21	18:31	321	430	194	770	771
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196	2011/10/12	21Z	21:25	21:33	336	380	194	770	771
197	2011/10/13	00Z	0:28	0:54	320	370	194	770	771
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205	2011/10/13	12Z	12:34	12:44	324	410	194	770	771
206	2011/10/13	12Z	12:52	13:01	320	380	194	770	771
207	2011/10/13	15Z	15:09	15:19	341	420	194	770	771
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213	2011/10/14	00Z	0:27	0:36	337	440	194	770	688
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215	2011/10/14	03Z	3:11	3:21	318	400	194	770	688
216	2011/10/14	03Z	3:31	3:40	332	410	194	770	688
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218	2011/10/14	06Z	6:55	7:03	328	380	194	770	688
219	2011/10/14	09Z	9:07	9:17	337	405	194	770	688
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222	2011/10/14	12Z	12:39	12:42	335	400	194	770	688
223	2011/10/14	15Z	15:10	15:19	321	400	194	770	688
224	2011/10/14	15Z	15:27	15:35	329	420	194	770	688
225	2011/10/14	18Z	18:21	18:30	316	350	194	770	688
226	2011/10/14	18Z	18:38	18:47	331	370	194	770	688
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230	2011/10/15	00Z	0:47	0:53	317	370	194	770	688
231	2011/10/15	03Z	3:10	3:19	306	410	194	770	688
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233	2011/10/15	06Z	6:37	6:46	308	390	194	770	688
234	2011/10/15	06Z	6:55	7:04	334	380	194	770	688
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237	2011/10/15	12Z	12:24	12:34	338	400	194	770	688
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240	2011/10/15	15Z	15:25	15:33	313	360	194	770	688
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249	2011/10/16	06Z	6:35	6:42	208	280	194	770	688
250	2011/10/16	06Z	6:47	6:53	208	280	194	770	688

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253	2011/10/16	09Z	9:27	9:33	226	290	194	770	688
254	2011/10/16	09Z	9:40	9:46	234	280	194	770	688
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257	2011/10/16	12Z	12:43	12:49	217	260	194	770	688
258	2011/10/16	15Z	15:08	15:14	209	240	194	770	688
259	2011/10/16	15Z	15:19	15:25	216	270	194	770	688
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261	2011/10/16	18Z	18:20	18:27	221	270	194	770	688
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283	2011/10/17	18Z	18:23	18:33	328	380	194	770	688
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310	2011/10/19	09Z	9:23	9:33	333	430	194	770	688
311	2011/10/19	12Z	12:21	12:32	329	380	194	770	688
312	2011/10/19	12Z	12:39	12:48	318	370	194	770	688
313	2011/10/19	15Z	15:08	15:18	337	370	194	770	688
314	2011/10/19	15Z	15:27	15:35	339	380	194	770	688
315	2011/10/19	18Z	18:19	18:28	327	400	194	770	688
316	2011/10/19	18Z	18:35	18:43	327	380	194	770	688
317	2011/10/19	21Z	21:07	21:18	360	410	194	770	688
318	2011/10/19	21Z	21:26	21:35	332	390	194	770	688
319	2011/10/20	00Z	0:24	0:33	326	380	194	770	688
320	2011/10/20	00Z	0:40	0:49	349	380	194	770	688
321	2011/10/20	03Z	3:10	3:20	331	370	194	770	688
322	2011/10/20	03Z	3:28	3:38	340	410	194	770	688
323	2011/10/20	06Z	6:18	6:27	313	370	194	770	688
324	2011/10/20	06Z	6:34	6:43	317	395	194	770	688
325	2011/10/20	06Z	6:51	6:59	321	400	194	770	688
326	2011/10/20	06Z	7:07	7:16	307	370	194	770	688
327	2011/10/20	06Z	7:23	7:31	308	380	194	770	688

328	2011/10/20	06Z	7:38	7:47	309	410	194	770	688
329	2011/10/20	09Z	9:17	9:26	297	400	194	770	688
330	2011/10/20	09Z	9:34	9:42	312	430	194	770	688
331	2011/10/20	09Z	9:50	9:58	323	440	194	770	688
332	2011/10/20	09Z	10:06	10:15	329	420	194	770	688
333	2011/10/20	09Z	10:22	10:31	318	390	194	770	688
334	2011/10/20	09Z	10:39	10:52	460	580	194	770	688
335	2011/10/20	12Z	12:21	12:30	309	420	194	770	688
336	2011/10/20	12Z	12:39	12:47	290	390	194	770	688
337	2011/10/20	12Z	12:55	13:04	342	410	194	770	688
338	2011/10/20	12Z	13:11	13:20	325	390	194	770	688
339	2011/10/20	12Z	13:29	13:38	331	400	194	770	688
340	2011/10/20	12Z	13:46	13:55	324	390	194	770	688
341	2011/10/20	15Z	15:09	15:18	331	400	194	770	688
342	2011/10/20	15Z	15:26	15:35	327	380	194	770	688
343	2011/10/20	15Z	15:41	15:50	329	380	194	770	688
344	2011/10/20	15Z	15:58	16:06	340	380	194	770	688
345	2011/10/20	15Z	16:13	16:22	326	370	194	770	688
346	2011/10/20	15Z	16:28	16:37	318	360	194	770	688
347	2011/10/20	15Z	16:43	16:52	325	380	194	770	688
348	2011/10/20	18Z	18:21	18:31	330	390	194	770	688
349	2011/10/20	18Z	18:38	18:47	322	380	194	770	688
350	2011/10/20	18Z	18:54	19:03	330	400	194	770	688
351	2011/10/20	18Z	19:11	19:20	318	400	194	770	688
352	2011/10/20	18Z	19:28	19:37	337	405	194	770	688
353	2011/10/20	18Z	19:44	19:53	329	390	194	770	688
354	2011/10/20	21Z	21:12	21:22	346	390	180	718	720
355	2011/10/20	21Z	21:30	21:40	342	400	180	718	720
356	2011/10/20	21Z	21:48	21:58	351	390	180	718	720
357	2011/10/20	21Z	22:06	22:15	342	390	180	718	720
358	2011/10/20	21Z	22:23	22:32	340	380	180	718	720
359	2011/10/20	21Z	22:39	22:49	349	410	180	718	720
360	2011/10/21	00Z	0:25	0:35	363	400	180	718	720
361	2011/10/21	00Z	0:43	0:53	360	420	180	718	720
362	2011/10/21	00Z	1:01	1:10	345	400	180	718	720
363	2011/10/21	00Z	1:18	1:28	339	400	180	718	720
364	2011/10/21	00Z	1:36	1:46	365	420	180	718	720
365	2011/10/21	00Z	1:54	2:04	362	430	180	718	720
366	2011/10/21	03Z	3:10	3:22	330	380	180	718	720
367	2011/10/21	03Z	3:29	3:39	361	400	180	718	720
368	2011/10/21	03Z	3:48	3:56	344	390	180	718	720
369	2011/10/21	03Z	4:07	4:16	360	420	180	718	720
370	2011/10/21	03Z	4:24	4:33	340	405	180	718	720
371	2011/10/21	03Z	4:41	4:51	346	390	180	718	720
372	2011/10/21	06Z	6:38	6:48	347	410	180	718	720
373	2011/10/21	06Z	6:59	7:07	321	380	180	718	720
374	2011/10/21	09Z	9:15	9:25	323	380	180	718	720
375	2011/10/21	09Z	9:33	9:43	352	405	180	718	720
376	2011/10/21	12Z	11:34	11:45	345	400	180	718	720
377	2011/10/21	12Z	11:53	12:03	349	410	180	718	720
378	2011/10/21	15Z	15:13	15:25	364	420	180	718	720
379	2011/10/21	15Z	15:33	15:42	356	400	180	718	720
380	2011/10/21	18Z	18:24	18:34	319	370	180	718	720
381	2011/10/21	18Z	18:41	18:50	338	400	180	718	720
382	2011/10/21	21Z	21:08	21:17	342	380	180	718	720
383	2011/10/21	21Z	21:24	21:33	338	380	180	718	720
384	2011/10/22	00Z	0:39	0:49	332	400	180	718	720
385	2011/10/22	00Z	0:57	1:06	332	400	180	718	720
386	2011/10/22	03Z	3:09	3:20	341	380	180	718	720
387	2011/10/22	03Z	3:28	3:37	356	405	180	718	720
388	2011/10/22	06Z	6:37	6:48	348	400	180	718	720
389	2011/10/22	06Z	6:55	7:05	361	430	180	718	720
390	2011/10/22	09Z	9:06	9:16	337	390	180	718	720
391	2011/10/22	09Z	9:24	9:34	353	410	180	718	720
392	2011/10/22	12Z	12:21	12:32	348	400	180	718	720
393	2011/10/22	12Z	12:40	12:50	339	400	180	718	720
394	2011/10/22	15Z	15:09	15:19	318	370	180	718	720
395	2011/10/22	15Z	15:26	15:35	338	370	180	718	720
396	2011/10/22	18Z	18:32	18:43	345	410	180	718	720
397	2011/10/22	18Z	18:50	18:59	345	390	180	718	720
398	2011/10/22	21Z	21:08	21:19	334	380	180	718	720
399	2011/10/22	21Z	21:25	21:34	345	410	180	718	720
400	2011/10/23	00Z	0:24	0:33	327	390	180	718	720
401	2011/10/23	00Z	0:41	0:50	352	420	180	718	720
402	2011/10/23	03Z	3:08	3:18	331	380	180	718	720
403	2011/10/23	03Z	3:26	3:35	336	370	180	718	720
404	2011/10/23	06Z	6:36	6:46	330	395	180	718	720

405	2011/10/23	06Z	6:53	7:03	342	410	180	718	720
406	2011/10/23	09Z	9:07	9:17	337	390	180	718	720
407	2011/10/23	09Z	9:26	9:35	351	410	180	718	720
408	2011/10/23	12Z	12:19	12:29	356	390	180	718	720
409	2011/10/23	12Z	12:36	12:46	348	380	180	718	720
410	2011/10/23	15Z	15:08	15:19	352	400	180	718	720
411	2011/10/23	15Z	15:26	15:35	351	390	180	718	720
412	2011/10/23	18Z	18:20	18:31	362	380	180	718	720
413	2011/10/23	18Z	18:39	18:48	335	370	180	718	720
414	2011/10/23	21Z	21:06	21:16	341	400	180	718	720
415	2011/10/23	21Z	21:23	21:32	347	400	180	718	720
416	2011/10/24	00Z	0:21	0:32	367	400	180	718	720
417	2011/10/24	00Z	0:39	0:48	346	390	180	718	720
418	2011/10/24	03Z	3:09	3:19	351	405	180	718	720
419	2011/10/24	03Z	3:27	3:45	671	730	180	718	720
420	2011/10/31	00Z	0:22	0:32	331	400	219	718	720
421	2011/10/31	00Z	0:38	0:46	327	400	219	718	720
422	2011/10/31	03Z	3:09	3:19	326	410	219	718	720
423	2011/10/31	03Z	3:28	3:36	337	400	219	718	720
424	2011/10/31	06Z	6:36	6:46	370	480	219	718	720
425	2011/10/31	06Z	6:55	7:03	320	380	219	718	720
426	2011/10/31	09Z	9:06	9:16	344	410	219	718	720
427	2011/10/31	09Z	9:24	9:33	350	420	219	718	720
428	2011/10/31	12Z	12:22	12:32	344	390	219	718	720
429	2011/10/31	12Z	12:39	12:48	349	410	219	718	720
430	2011/10/31	15Z	15:14	15:22	330	400	219	718	720
431	2011/10/31	15Z	15:29	15:38	340	400	219	718	720
432	2011/10/31	18Z	18:20	18:31	372	430	219	718	720
433	2011/10/31	18Z	18:40	18:49	344	400	219	718	720
434	2011/10/31	21Z	21:06	21:16	347	400	219	718	720
435	2011/10/31	21Z	21:24	21:33	352	405	219	718	720
436	2011/11/01	00Z	0:22	0:32	337	410	219	718	720
437	2011/11/01	00Z	0:39	0:39	331	410	219	718	720
438	2011/11/01	03Z	3:07	3:16	312	350	219	718	720
439	2011/11/01	03Z	3:23	3:31	323	370	219	718	720
440	2011/11/01	06Z	6:36	6:46	323	360	219	718	720
441	2011/11/01	06Z	6:53	7:02	341	390	219	718	720
442	2011/11/01	09Z	9:05	09:14	332	380	219	718	720
443	2011/11/01	09Z	9:21	09:30	340	400	219	718	720
444	2011/11/01	12Z	12:23	12:33	342	410	219	718	720
445	2011/11/01	12Z	12:40	12:49	336	405	219	718	720
446	2011/11/01	15Z	15:08	15:17	320	410	219	718	720
447	2011/11/01	15Z	15:24	15:34	326	410	219	718	720
448	2011/11/01	18Z	18:22	18:32	344	410	219	718	720
449	2011/11/01	18Z	18:39	18:48	324	370	219	718	720
450	2011/11/01	21Z	21:08	21:18	340	400	219	718	720
451	2011/11/01	21Z	21:25	21:34	342	420	219	718	720
452	2011/11/02	00Z	0:19	00:29	327	370	219	718	720
453	2011/11/02	00Z	0:35	00:43	308	350	219	718	720
454	2011/11/02	03Z	3:08	3:18	331	430	219	718	720
455	2011/11/02	03Z	3:28	03:36	308	370	219	718	720
456	2011/11/02	06Z	6:05	0646	366	430	219	718	797
457	2011/11/02	06Z	6:55	07:04	339	390	219	718	797
458	2011/11/02	09Z	9:06	09:16	337	400	219	718	797
459	2011/11/02	09Z	9:23	09:32	337	390	219	718	797
460	2011/11/02	12Z	12:20	12:29	305	380	219	720	718
461	2011/11/02	12Z	12:36	12:44	320	390	219	720	718
462	2011/11/02	15Z	15:15	15:24	319	410	219	720	718
463	2011/11/02	15Z	15:31	15:40	334	400	219	720	718
464	2011/11/02	18Z	18:27	18:38	355	420	219	798	718
465	2011/11/02	18Z	18:51	18:53	352	410	219	798	718
466	2011/11/02	21Z	21:12	21:22	361	430	219	798	718
467	2011/11/02	21Z	21:29	21:39	345	410	219	798	718
468	2011/11/03	00Z	0:22	0:31	319	370	219	798	718
469	2011/11/03	00Z	0:37	0:45	322	390	219	798	718
470	2011/11/03	03Z	3:15	3:28	321	390	219	799	718
471	2011/11/03	03Z	3:35	3:44	319	390	219	799	718
472	2011/11/03	06Z	6:42	6:51	319	380	219	799	718
473	2011/11/03	06Z	6:58	7:06	320	370	219	799	718
474	2011/11/03	09Z	9:10	9:21	361	420	219	799	718
475	2011/11/03	09Z	9:28	9:37	345	390	219	799	718
476	2011/11/03	12Z	12:25	12:35	344	400	219	718	800
477	2011/11/03	12Z	12:42	12:51	345	395	219	718	800
478	2011/11/03	15Z	15:15	15:25	346	410	219	718	800
479	2011/11/03	15Z	15:31	15:40	335	410	219	718	800
480	2011/11/03	18Z	18:24	18:35	348	390	219	718	800
481	2011/11/03	18Z	18:40	18:50	373	430	219	718	800

482	2011/11/03	21Z	21:10	21:20	358	420	219	718	800
483	2011/11/03	21Z	21:27	21:36	345	400	219	718	800
484	2011/11/04	00Z	0:26	0:36	317	355	219	718	800
485	2011/11/04	00Z	0:41	0:50	322	360	219	718	800
486	2011/11/04	03Z	3:14	3:24	322	360	219	718	800
487	2011/11/04	03Z	3:30	3:38	309	350	219	718	800
488	2011/11/04	06Z	6:42	6:51	339	390	219	718	800
489	2011/11/04	06Z	6:58	7:07	329	360	219	718	800
490	2011/11/04	09Z	9:11	9:20	337	390	219	718	800
491	2011/11/04	09Z	9:27	9:35	332	380	219	718	800
492	2011/11/04	12Z	12:23	12:34	346	420	219	718	800
493	2011/11/04	12Z	12:41	12:51	344	410	219	718	800
494	2011/11/04	15Z	15:12	15:22	343	400	219	718	800
495	2011/11/04	15Z	15:28	15:39	412	500	219	718	800
496	2011/11/04	18Z	18:24	18:34	338	400	219	718	800
497	2011/11/04	18Z	18:40	18:49	340	410	219	718	800
498	2011/11/04	21Z	21:09	21:19	329	400	219	718	800
499	2011/11/04	21Z	21:25	21:35	348	420	219	718	800
500	2011/11/05	00Z	0:24	0:33	314	380	219	718	800
501	2011/11/05	00Z	0:38	0:47	316	380	219	718	800
502	2011/11/05	03Z	3:12	3:22	328	390	219	718	800
503	2011/11/05	03Z	3:29	3:38	311	360	219	718	800
504	2011/11/05	06Z	6:43	6:53	320	390	219	718	800
505	2011/11/05	06Z	7:00	7:08	311	390	219	718	800
506	2011/11/05	09Z	9:09	9:18	324	410	219	718	800
507	2011/11/05	09Z	9:25	9:37	422	500	219	718	800
508	2011/11/05	12Z	12:24	12:34	331	390	219	718	800
509	2011/11/05	12Z	12:40	12:49	323	400	219	718	800
510	2011/11/05	15Z	15:12	15:22	340	400	219	718	800
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512	2011/11/05	18Z	18:24	18:34	340	400	219	718	800
513	2011/11/05	18Z	18:41	18:50	326	390	219	718	800
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515	2011/11/05	21Z	21:27	21:36	327	400	219	718	800
516	2011/11/06	00Z	0:27	0:36	317	400	219	718	800
517	2011/11/06	00Z	0:41	0:50	316	400	219	718	800
518	2011/11/06	03Z	2:39	2:49	324	420	219	718	800
519	2011/11/06	03Z	2:57	3:07	323	400	219	718	800
520	2011/11/06	06Z	6:41	6:50	336	390	219	718	800
521	2011/11/06	06Z	6:58	7:07	331	380	219	718	800
522	2011/11/06	09Z	9:11	9:22	354	420	219	718	800
523	2011/11/06	09Z	9:29	9:37	341	400	219	718	800
524	2011/11/06	12Z	12:23	12:33	346	410	219	718	800
525	2011/11/06	12Z	12:40	12:49	338	390	219	718	800
526	2011/11/06	15Z	15:13	15:23	336	410	219	718	800
527	2011/11/06	15Z	15:28	15:37	337	390	219	718	800
528	2011/11/06	18Z	18:23	18:34	344	400	219	718	800
529	2011/11/06	18Z	18:40	18:50	342	400	219	718	800
530	2011/11/06	21Z	21:08	21:18	352	410	219	718	800
531	2011/11/06	21Z	21:26	21:35	334	390	219	718	800
532	2011/11/07	00Z	0:21	0:31	330	380	219	718	800
533	2011/11/07	00Z	0:37	0:45	321	370	219	718	800
534	2011/11/07	03Z	3:13	3:23	318	405	219	718	800
535	2011/11/07	03Z	3:30	3:38	327	390	219	718	800
536	2011/11/07	06Z	6:40	6:50	327	390	219	718	800
537	2011/11/07	06Z	6:57	7:06	323	370	219	718	800
538	2011/11/07	09Z	9:10	9:18	317	410	219	718	800
539	2011/11/07	09Z	9:26	9:35	332	390	219	718	800
540	2011/11/07	12Z	12:24	12:34	334	410	219	718	800
541	2011/11/07	12Z	12:41	12:49	323	390	219	718	800
542	2011/11/07	15Z	15:12	15:22	331	400	219	718	800
543	2011/11/07	15Z	15:28	15:37	335	405	219	718	800
544	2011/11/07	18Z	18:24	18:34	334	420	219	718	800
545	2011/11/07	18Z	18:42	18:51	338	410	219	718	800
546	2011/11/07	21Z	21:08	21:18	329	400	219	718	800
547	2011/11/07	21Z	21:26	21:35	340	410	219	718	800
548	2011/11/08	00Z	0:21	0:31	325	390	219	718	800
549	2011/11/08	00Z	0:35	0:44	313	390	219	718	800
550	2011/11/08	03Z	3:13	3:22	317	390	219	718	800
551	2011/11/08	03Z	3:28	3:37	314	390	219	718	800
552	2011/11/08	06Z	6:42	6:52	313	400	219	718	800
553	2011/11/08	06Z	6:59	7:08	321	360	219	718	800
554	2011/11/08	09Z	9:09	9:19	335	390	219	718	800
555	2011/11/08	09Z	9:26	9:35	338	390	219	718	800
556	2011/11/08	12Z	12:23	12:33	343	390	219	718	800
557	2011/11/08	12Z	12:40	12:49	340	390	219	718	800
558	2011/11/08	15Z	15:11	15:21	343	390	219	718	800

559	2011/11/08	15Z	15:27	15:36	331	390	219	718	800
560	2011/11/08	18Z	18:23	18:34	352	400	219	718	800
561	2011/11/08	18Z	18:40	18:49	342	390	219	718	800
562	2011/11/08	21Z	21:09	21:19	332	370	219	718	800
563	2011/11/08	21Z	21:26	21:38	341	380	219	718	800
564	2011/11/09	00Z	0:23	0:32	326	360	219	718	800
565	2011/11/09	00Z	0:38	0:47	322	360	219	718	800
566	2011/11/09	03Z	3:11	3:21	321	380	219	718	800
567	2011/11/09	03Z	3:28	3:37	319	380	219	718	800
568	2011/11/09	06Z	6:45	6:54	330	390	219	718	800
569	2011/11/09	06Z	7:01	7:12	353	440	219	718	800
570	2011/11/09	09Z	9:09	9:19	341	390	219	718	800
571	2011/11/09	09Z	9:26	9:35	332	390	219	718	800
572	2011/11/09	12Z	12:23	12:33	333	390	219	718	800
573	2011/11/09	12Z	12:40	12:48	313	380	219	718	800
574	2011/11/09	15Z	15:12	15:22	327	390	219	718	800
575	2011/11/09	15Z	15:28	15:36	320	380	219	718	800
576	2011/11/09	18Z	18:25	18:35	328	390	219	718	800
577	2011/11/09	18Z	18:41	18:50	327	370	219	718	800
578	2011/11/09	21Z	21:07	21:17	341	380	219	718	800
579	2011/11/09	21Z	21:25	21:35	323	360	219	718	800
580	2011/11/10	00Z	0:24	0:33	312	350	219	718	800
581	2011/11/10	00Z	0:38	0:47	306	350	219	718	800
582	2011/11/10	03Z	3:13	3:22	296	410	219	718	800
583	2011/11/10	03Z	3:29	3:38	321	440	219	718	800
584	2011/11/10	06Z	6:40	6:50	325	420	219	718	800
585	2011/11/10	06Z	6:58	7:08	335	420	219	718	800
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587	2011/11/10	09Z	9:27	9:36	333	390	219	718	800
588	2011/11/10	12Z	12:24	12:33	332	390	219	718	800
589	2011/11/10	12Z	12:42	12:50	333	390	219	718	800
590	2011/11/10	15Z	15:11	15:21	323	410	219	718	800
591	2011/11/10	15Z	15:27	15:36	316	410	219	718	800
592	2011/11/10	18Z	18:23	18:32	328	390	219	718	800
593	2011/11/10	18Z	18:39	18:47	325	380	219	718	800
594	2011/11/10	21Z	21:06	21:16	324	360	219	718	800
595	2011/11/10	21Z	21:23	21:32	328	380	219	718	800
596	2011/11/11	00Z	0:23	0:33	318	340	219	718	800
597	2011/11/11	00Z	0:40	0:48	325	380	219	718	800
598	2011/11/11	03Z	3:12	3:21	330	410	219	718	800
599	2011/11/11	03Z	3:28	3:37	318	390	219	718	800
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602	2011/11/11	09Z	9:17	9:27	337	405	219	718	800
603	2011/11/11	09Z	9:34	9:43	330	370	219	718	800
604	2011/11/11	12Z	12:24	12:34	332	380	219	718	800
605	2011/11/11	12Z	12:41	12:50	333	380	219	718	800
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617	2011/11/12	06Z	7:00	7:08	313	420	219	718	800
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621	2011/11/12	12Z	12:35	12:44	314	390	219	718	800
622	2011/11/12	15Z	15:12	15:22	320	380	219	718	799
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624	2011/11/12	18Z	18:24	18:33	322	380	219	718	771
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626	2011/11/12	21Z	21:24	21:33	328	380	219	718	771
627	2011/11/12	21Z	21:40	21:48	325	390	219	718	771
628	2011/11/13	00Z	0:26	0:35	326	360	219	718	771
629	2011/11/13	00Z	0:41	0:50	325	360	219	718	771
630	2011/11/13	03Z	3:08	3:17	326	390	219	718	771
631	2011/11/13	03Z	3:24	3:32	306	370	219	718	771
632	2011/11/13	06Z	6:43	6:53	320	410	219	718	771
633	2011/11/13	06Z	7:00	7:08	332	390	219	718	771
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636	2011/11/13	12Z	12:22	12:32	319	370	219	718	771
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638	2011/11/13	15Z	15:15	15:25	326	390	219	718	771
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647	2011/11/14	03Z	3:26	3:35	322	380	219	718	771
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653	2011/11/14	12Z	12:41	12:49	324	390	219	718	771
654	2011/11/14	15Z	15:10	15:20	320	400	219	718	771
655	2011/11/14	15Z	15:27	15:35	325	390	219	718	771
656	2011/11/14	18Z	18:37	18:46	321	430	219	718	771
657	2011/11/14	18Z	18:54	19:02	317	400	219	718	771
658	2011/11/14	21Z	21:11	21:21	321	390	219	718	771
659	2011/11/14	21Z	21:29	21:38	323	390	219	718	771
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710	2011/11/18	03Z	3:11	3:20	315	390	219	718	800
711	2011/11/18	03Z	3:28	3:37	326	390	219	718	800
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721	2011/11/18	18Z	18:48	18:57	324	420	219	718	800
722	2011/11/18	21Z	21:11	21:20	308	460	219	718	800
723	2011/11/18	21Z	21:29	21:38	325	430	219	718	800
724	2011/11/19	00Z	0:26	0:34	311	420	219	718	800
725	2011/11/19	00Z	0:40	0:48	305	430	219	718	800
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727	2011/11/19	03Z	3:34	3:43	339	450	219	718	800
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737	2011/11/19	18Z	18:46	18:55	337	420	219	718	800
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741	2011/11/20	00Z	0:39	0:47	323	400	219	718	800
742	2011/11/20	03Z	3:13	3:22	312	420	219	718	800
743	2011/11/20	03Z	3:28	3:36	324	420	219	718	800
744	2011/11/20	06Z	6:39	6:49	331	410	219	718	800
745	2011/11/20	06Z	6:56	7:05	339	400	219	718	800
746	2011/11/20	09Z	9:10	9:20	327	390	219	718	800
747	2011/11/20	09Z	9:27	9:36	338	410	219	718	800
748	2011/11/20	12Z	12:23	12:33	323	405	219	718	800
749	2011/11/20	12Z	12:41	12:49	319	410	219	718	800
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753	2011/11/20	18Z	18:43	18:51	317	390	219	718	800
754	2011/11/20	21Z	21:10	21:20	315	390	219	718	800
755	2011/11/20	21Z	21:28	21:36	308	390	219	718	800
756	2011/11/21	00Z	0:26	0:34	313	380	219	718	800
757	2011/11/21	00Z	0:39	0:48	312	370	219	718	800
758	2011/11/21	03Z	3:11	3:20	318	390	219	718	800
759	2011/11/21	03Z	3:27	3:36	312	400	219	718	800
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761	2011/11/21	06Z	6:56	7:06	335	390	219	718	800
762	2011/11/21	09Z	9:09	9:19	318	410	219	718	800
763	2011/11/21	09Z	9:26	9:34	313	410	219	718	800
764	2011/11/21	12Z	12:22	12:32	311	410	219	718	800
765	2011/11/21	12Z	12:39	12:47	317	400	219	718	800
766	2011/11/21	15Z	15:13	15:22	308	390	219	718	800
767	2011/11/21	15Z	15:28	15:37	304	390	219	718	800
768	2011/11/21	18Z	18:24	18:34	323	390	219	718	800
769	2011/11/21	18Z	18:41	18:50	324	390	219	718	800
770	2011/11/21	21Z	21:12	21:21	310	390	219	718	800
771	2011/11/21	21Z	21:29	21:37	316	400	219	718	800
772	2011/11/22	00Z	0:21	0:30	305	370	219	718	800
773	2011/11/22	00Z	0:35	0:44	308	380	219	718	800
774	2011/11/22	03Z	3:10	3:20	315	390	219	718	800
775	2011/11/22	03Z	3:25	3:32	304	390	219	718	800
776	2011/11/22	06Z	6:38	6:48	313	380	219	718	800
777	2011/11/22	06Z	6:54	7:03	321	380	219	718	800
778	2011/11/22	09Z	9:09	9:19	322	390	219	718	800
779	2011/11/22	09Z	9:26	9:35	332	390	219	718	800
780	2011/11/22	12Z	12:22	12:31	315	390	219	718	800
781	2011/11/22	12Z	12:39	12:47	313	400	219	718	800
782	2011/11/22	15Z	15:10	15:19	315	405	219	718	800
783	2011/11/22	15Z	15:25	15:33	319	400	219	718	800
784	2011/11/22	18Z	18:24	18:34	322	400	219	718	800
785	2011/11/22	18Z	18:44	18:52	323	400	219	718	800
786	2011/11/22	21Z	21:13	21:23	330	400	219	718	800
787	2011/11/22	21Z	21:30	21:39	339	410	219	718	800
788	2011/11/23	00Z	0:25	0:34	315	370	219	718	800
789	2011/11/23	00Z	0:40	0:49	318	380	219	718	800

790	2011/11/23	03Z	3:10	3:19	318	420	219	718	800
791	2011/11/23	03Z	3:24	0:32	317	410	219	718	800
792	2011/11/23	06Z	6:39	6:49	332	410	219	718	800
793	2011/11/23	06Z	6:56	7:04	326	380	219	718	800
794	2011/11/23	09Z	9:11	9:21	344	400	219	718	800
795	2011/11/23	09Z	9:28	9:37	329	380	219	718	800
796	2011/11/23	12Z	12:21	12:31	337	410	219	718	800
797	2011/11/23	12Z	12:39	12:48	341	400	219	718	800
798	2011/11/23	15Z	15:10	15:20	328	410	219	718	800
799	2011/11/23	15Z	15:25	15:33	327	410	219	718	800
800	2011/11/23	18Z	18:25	18:34	320	400	219	718	800
801	2011/11/23	18Z	18:41	18:50	329	410	219	718	800
802	2011/11/23	21Z	21:13	21:23	335	390	219	718	800
803	2011/11/23	21Z	21:29	21:39	335	430	219	718	800
804	2011/11/24	00Z	0:23	0:32	313	390	219	718	800
805	2011/11/24	00Z	0:37	0:45	317	400	219	718	800
806	2011/11/24	03Z	3:23	3:32	312	430	219	718	800
807	2011/11/24	03Z	3:37	3:46	311	420	219	718	800
808	2011/11/24	06Z	6:49	6:58	318	420	219	718	800
809	2011/11/24	06Z	7:05	7:14	317	410	219	718	800
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812	2011/11/24	12Z	12:24	12:33	315	440	219	718	800
813	2011/11/24	12Z	12:41	12:50	311	450	219	718	800
814	2011/11/24	15Z	15:12	15:21	303	400	219	718	800
815	2011/11/24	15Z	15:27	15:35	304	410	219	718	800
816	2011/11/24	18Z	18:28	18:37	321	390	219	718	800
817	2011/11/24	18Z	18:43	18:51	306	420	219	718	800
818	2011/11/24	21Z	21:16	21:25	314	430	219	718	800
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822	2011/11/25	03Z	3:14	3:23	312	450	219	718	800
823	2011/11/25	03Z	3:30	3:39	316	430	219	718	800
824	2011/11/25	06Z	6:45	6:55	320	410	219	718	800
825	2011/11/25	06Z	7:02	7:11	328	410	219	718	800
826	2011/11/25	09Z	9:14	9:24	325	390	219	718	800
827	2011/11/25	09Z	9:31	9:40	332	390	219	718	800
828	2011/11/25	12Z	12:22	12:31	305	390	219	718	800
829	2011/11/25	12Z	12:38	12:46	304	430	219	718	800
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831	2011/11/25	15Z	15:28	15:36	319	390	219	718	800
832	2011/11/25	18Z	18:32	18:35	62	120	219	718	800
833	2011/11/25	18Z	18:39	18:48	333	400	219	718	800
834	2011/11/25	18Z	18:55	19:04	331	390	219	718	800
835	2011/11/25	21Z	21:05	21:15	327	380	219	718	800
836	2011/11/25	21Z	21:21	21:30	338	420	219	718	800
837	2011/11/26	00Z	0:24	0:34	328	400	219	718	800
838	2011/11/26	00Z	0:40	0:49	320	390	219	718	800
839	2011/11/26	03Z	3:10	3:20	305	380	219	718	800
840	2011/11/26	03Z	3:26	3:32	328	410	219	718	800
841	2011/11/26	06Z	6:42	6:52	326	430	219	718	800
842	2011/11/26	06Z	6:59	7:09	328	420	219	718	800
843	2011/11/26	09Z	9:11	9:21	330	430	219	718	800
844	2011/11/26	09Z	9:29	9:38	335	420	219	718	800
845	2011/11/26	12Z	12:22	12:31	324	410	219	718	800
846	2011/11/26	12Z	12:39	12:47	321	400	219	718	800
847	2011/11/26	15Z	15:11	15:20	326	420	219	718	800
848	2011/11/26	15Z	15:26	15:35	320	410	219	718	800
849	2011/11/26	18Z	18:28	18:38	350	410	219	718	800
850	2011/11/26	18Z	18:45	18:53	330	400	219	718	800
851	2011/11/26	21Z	21:12	21:22	332	400	219	718	800
852	2011/11/26	21Z	21:29	21:38	331	410	219	718	800
853	2011/11/27	00Z	0:25	0:34	312	360	219	718	800
854	2011/11/27	00Z	0:40	0:48	317	390	219	718	800
855	2011/11/27	03Z	3:11	3:21	320	390	219	718	800
856	2011/11/27	03Z	3:27	3:35	317	380	219	718	800
857	2011/11/27	06Z	6:42	6:52	325	410	219	718	800
858	2011/11/27	06Z	6:59	7:08	331	420	219	718	800
859	2011/11/27	09Z	9:11	9:20	325	420	219	718	800
860	2011/11/27	09Z	9:28	9:36	321	380	219	718	800
861	2011/11/27	12Z	12:23	12:33	312	370	219	718	800
862	2011/11/27	12Z	12:40	12:48	310	370	219	718	800
863	2011/11/27	15Z	15:10	15:19	295	370	219	718	800
864	2011/11/27	15Z	15:24	15:33	332	430	219	718	800
865	2011/11/27	18Z	18:27	18:36	314	370	219	718	800
866	2011/11/27	18Z	18:42	18:50	315	390	219	718	800

867	2011/11/27	21Z	21:14	21:23	298	380	219	718	800
868	2011/11/27	21Z	21:29	21:38	325	440	219	718	800
869	2011/11/28	00Z	00]22	0:31	325	430	219	718	800
870	2011/11/28	00Z	0:37	0:45	312	390	219	718	800
871	2011/11/28	03Z	3:11	3:20	316	410	219	718	800
872	2011/11/28	03Z	3:27	3:36	337	420	219	718	800
873	2011/11/28	06Z	6:41	6:51	331	390	219	718	800
874	2011/11/28	06Z	6:57	7:10	455	500	219	718	800

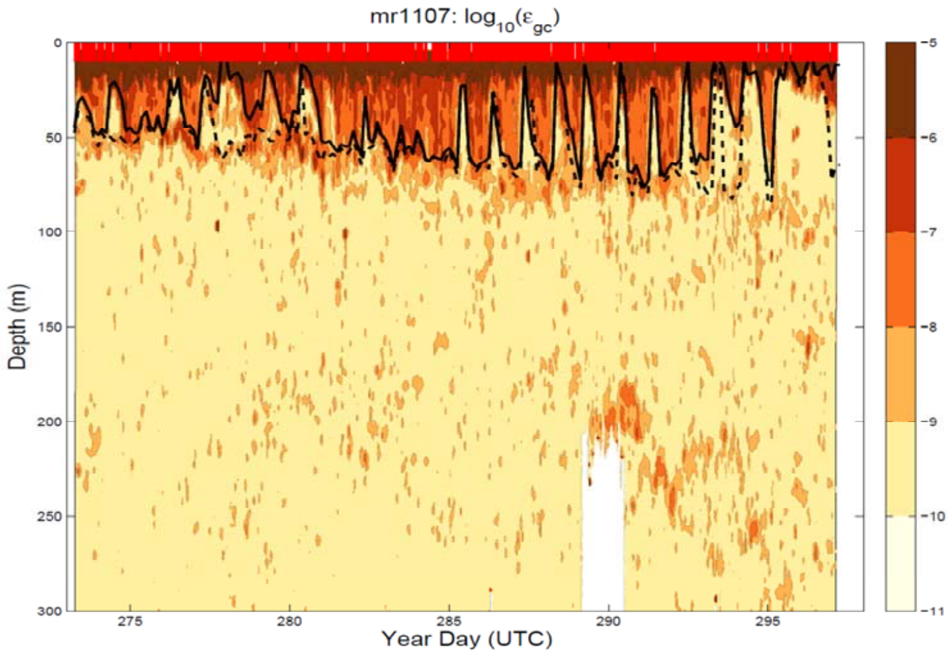


Fig.5.20-1: Time-depth cross section of the dissipation ratio of the kinematic energy during Leg-1 (Sep.30 [Day 273] to Oct.24 [Day 297]).

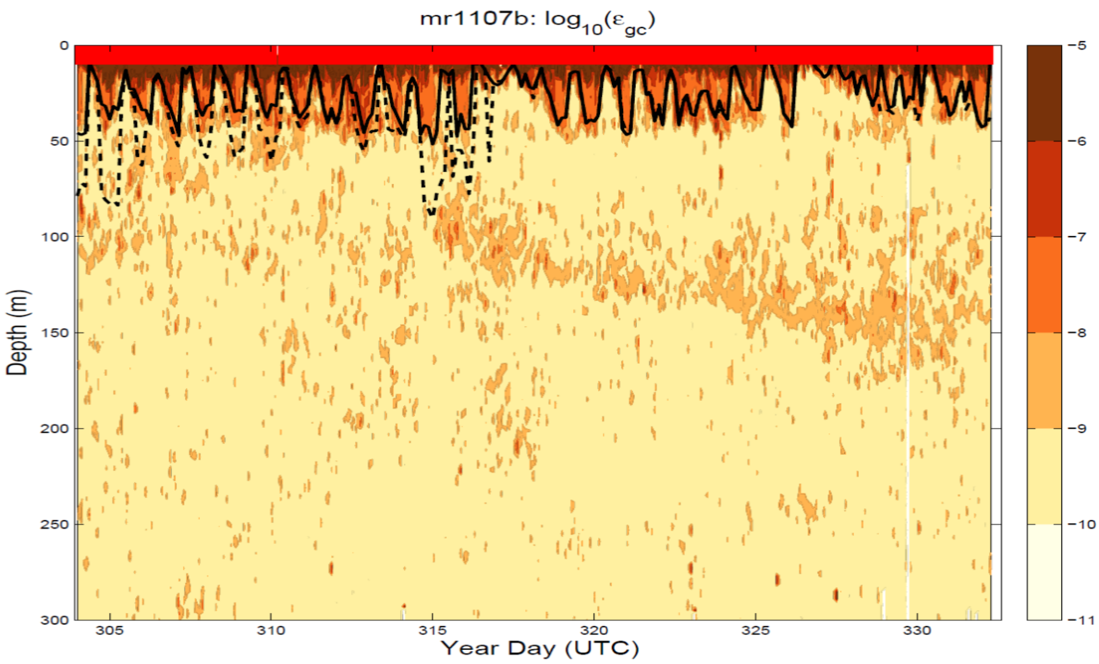


Fig.5.20-2: Same as Fig. 5.20-1, except for Leg-2 (Oct.31 [Day 304] to Nov.28 [Day 332]).

5.21 LADCP

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Andrei Natarov*** (IPRC, University of Hawai`i)
Kelvin Richards* (Department of Oceanography, IPRC, University of Hawai`i)
Kenichi Katayama** (MWJ)
Tomohide Noguchi** (MWJ)

(2) Objective

To produce high vertical resolution horizontal velocity measurements.

(3) Overview of instrument and operation

To measure velocity structure at small vertical scales we used a high frequency ADCP in lowered mode (LADCP). The instrument, a Teledyne RDI Workhorse Sentinel 600kHz ADCP rated for 1000m depth, was attached to the CTD frame using a wide metal collar made of two halves joined by six retaining bolts (three on each side, as shown in Figure 1). A rubber sleeve was wrapped around the instrument to prevent direct contact between the instrument and the metal collar and to prevent vertical slippage. A rope was tied to the top of the instrument and attached to the CTD frame to further reduce vertical slippage and for added safety. The instrument was deployed on CTD stations 5SM001, 5SM002, 8SM001 through 8SM420 and performed well throughout its use.

Fig. 5.21-1: Teledyne RDI Workhorse Sentinel 600kHz ADCP attached to the CTD frame

The instrument is self-contained with an internal battery pack. The health of the battery is monitored by the recorded voltage count. The relationship between the actual battery voltage and the recorded voltage count is obscure and appears to vary with the instrument and environmental conditions. Taking a direct measurement of the state of the battery requires opening up the instrument. Two batteries (one for each leg) were used in the course of the mr11-07 cruise. Direct measurements of the battery voltage were taken before and after each leg and compared to the recorded voltage count. The results, summarized in Table 1, show an almost constant relationship of V~=0.29VC. RDI recommend the battery is changed when V gets below 30V.

Table 1. Battery characteristics before and after the deployment.

Leg 1

	Battery Voltage (V)	Voltage Count (VC)	ratio (V/VC)
Before	44.6	155	0.29
After	36.8	125	0.29

Leg 2

	Battery Voltage (V)	Voltage Count (VC)	ratio (V/VC)
Before	44.6	154	0.29
After	36.0	122	0.29

(4) Data processing

An initial sampling of the data was made using the following scripts to check that the instrument was performing correctly

scanbb - integrity check
plot_PTCV.py - plot pressure, temperature, voltage and current counts
plot_vel.py - plot velocity from all 4 beams

The principal onboard data processing was performed using the Lamont Doherty Earth Observatory (LDEO, Columbia University) LADCP software package version IX_4 (available at ftp://ftp.ldeo.columbia.edu/pub/ant/LADCP). The package, consisting of a number of matlab scripts, solves a set of inverse problems using LADCP raw data, incorporating CTD (for depth) and GPS data, to provide a vertical profile of the horizontal components of velocity, U and V (eastward and northward, respectively), that is a best fit to specified constraints. The down- and up-casts are solved separately, as well as the full cast inverse. The package also calculates U and V from the vertical shear of velocity.

The software is run using the matlab script **process_cast.m** with the configuration file **set_cast_params.m**. Frequent CTD data are required. Files of 1 second averaged CTD data were prepared for each cast. Accurate time keeping is essential, particularly between the CTD and GPS data. To ensure this the CTD data records also included the GPS position. The LDEO software allows the ship's ADCP data (SADCP) to be included in the inverse calculation. The SADCP data were not included on this cruise so as to provide an independent check on the functioning of the LADCP.

On-station SADCP velocity profiles were produced by averaging the five minute averaged profiles (mr1107L1004_000000.LTA for Leg 1 and mr1107L2001_000000.LTA for Leg 2 produced using *VmDAS*) over the period of the CTD/LADCP cast.

(5) Preliminary results

Figures 2 and 3 show the time series for the zonal (eastward) and meridional (northward) velocity components in the upper 300 meters for both legs of the cruise. The upward phase propagation is consistent with the dynamics of the near-inertial waves (NIWs) radiated from the mixed layer into the ocean interior.

Further evidence for the near-inertial nature of the wave pattern seen in these figures comes from the temporal frequency spectra (figures 4 and 5), which reveal a strong peak around the 4-day (i.e., the local inertial) period in the upper 50 meters.

Another near-surface feature seen in the frequency-depth diagrams is the distinct peak at approximately 6-day period. We conjecture that this may be a response to an atmospheric wave with a 6-day period described in Yasunaga *et al*. 2010, but a more complete analysis will be performed after the cruise.

At greater depths the signal is dominated by somewhat higher frequencies and is consistent with propagation of NIWs generated at lower latitudes (8S to 12S) towards the equator.

Comparison of the LADCP velocity with the turbulent kinetic energy dissipation profiles obtained using microstructure measurements (TurboMAP) has proven to be very helpful in illuminating the physics of observed phenomena. Figure 6 shows shear S2 calculated from the LADCP velocity, and figure 7 shows the turbulent kinetic energy dissipation rate epsilon. The period of high epsilon between 170 and 300m near the end of Leg 1 seen in figure 6a is accompanied by the period of high S2 arising from an energetic NIW propagating through this range of depths during this time interval. A similar pattern can be seen between 100 and 150m depths at the end of Leg 2.

(6) Data archive

All raw datasets will be submitted to JAMSTEC Data Management Office (DMO).

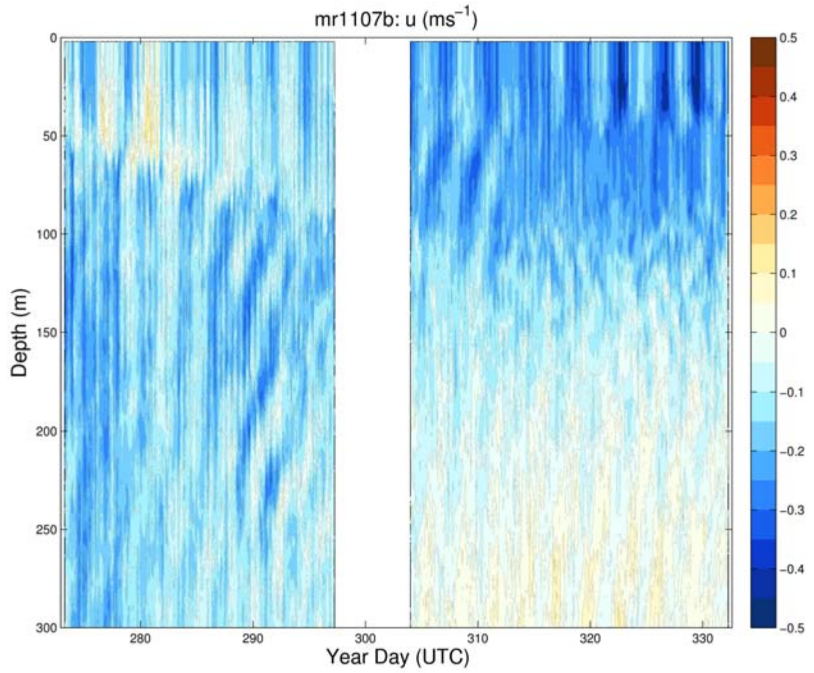


Fig. 5.21-2: Zonal (eastward) velocity time series.

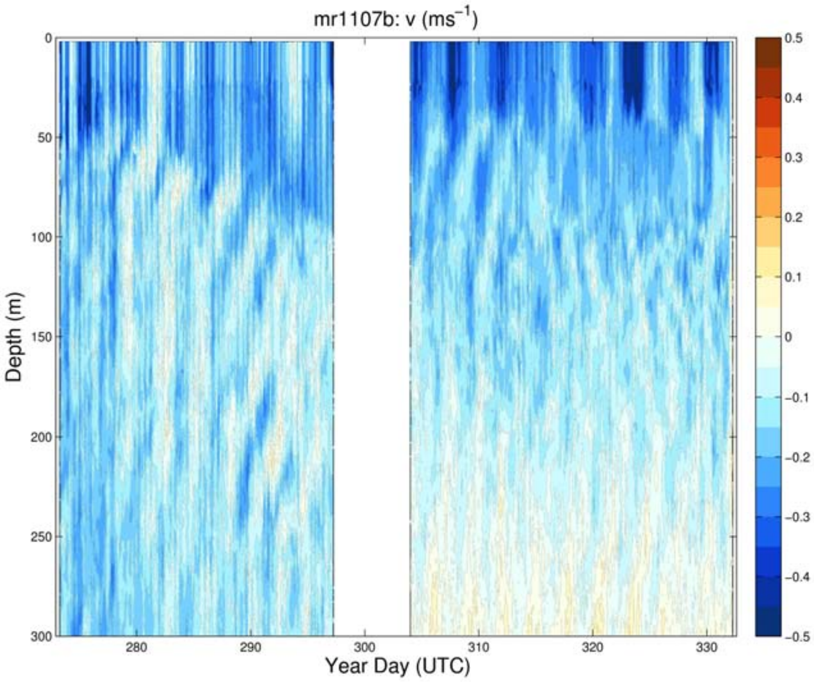


Fig. 5.21-3: Meridional (northward) velocity time series.

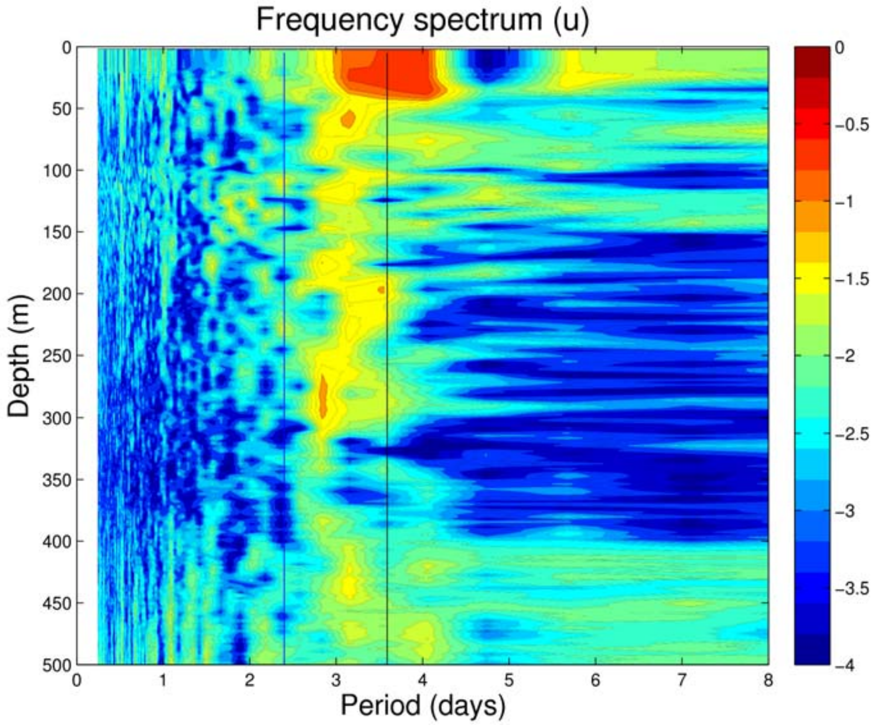


Fig. 5.21-4: Frequency-depth diagram for the zonal velocity U (Leg 2)

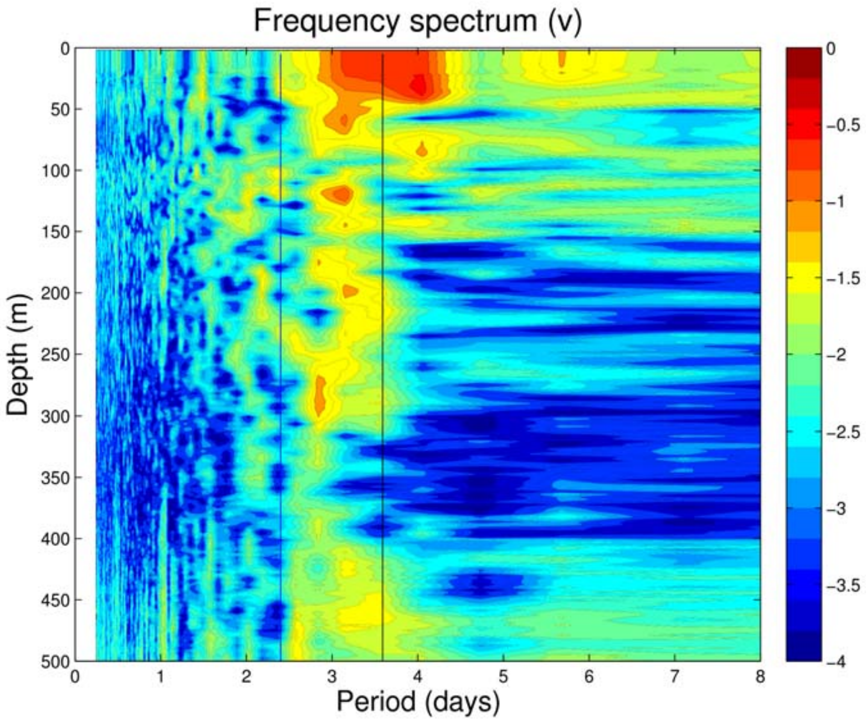


Fig. 5.21-5: Frequency-depth diagram for the meridional velocity V (Leg 2)

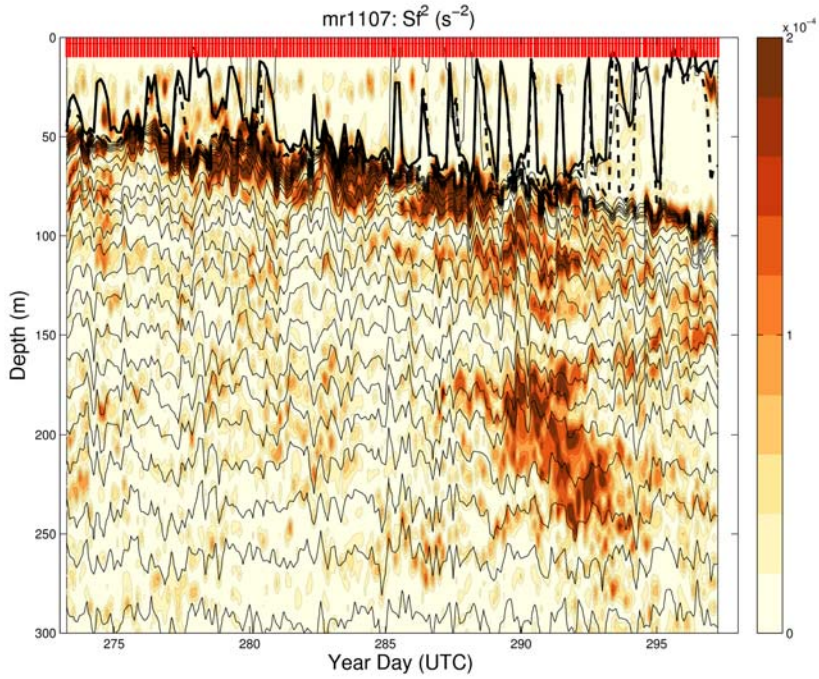


Fig. 5.21-6: LADCP velocity shear (S2) time series (Leg-1)

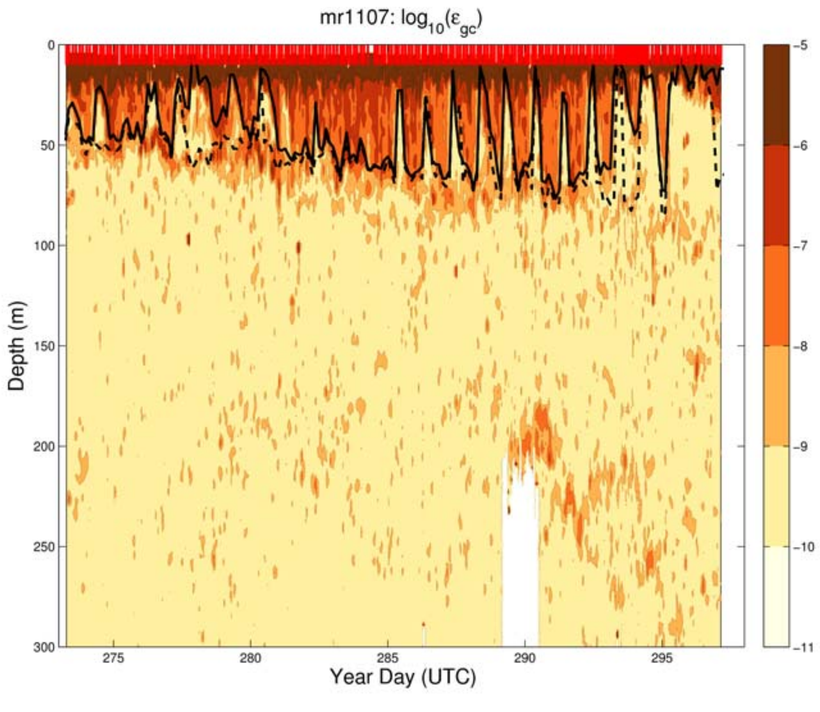


Fig. 5.21-7: Time series for the turbulent kinetic energy dissipation rate (epsilon) estimated from microstructure measurements (Leg-1)

5.22 Shipboard ADCP

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Kunio YONEYAMA*	(JAMSTEC)	- Principal Investigator (Leg-1)
Masaki KATSUMATA***	(JAMSTEC)	- Principal Investigator (Leg-2)
Souichiro SUEYOSHI***	(GODI)	- Operation Leader (Leg-1 and 2)
Asuka DOI***	(GODI)	
Toshimitsu GOTO***	(GODI)	
Katsuaki MAENO*	(GODI)	
Ryo KIMURA*	(GODI)	
Satoshi OKUMURA**	(GODI)	
Kazuho YOSHIDA**	(GODI)	
Wataru TOKUNAGA ***	(MIRAI Crew)	

(2) Objective

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

(3) Methods

Upper ocean current measurements were made in MR11-07 cruise, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system, which consists of following components;

1) R/V MIRAI has installed vessel-mount ADCP (75 kHz "Ocean Surveyor", Teledyne RD Instruments). It has a phased-array transducer with single assembly and creates 4 acoustic beams electronically.
2) For heading source, we use ship's gyro compass (Tokimec, Japan), continuously providing heading to the ADCP system directory. Also we have Inertial Navigation System (PHINS, iXSEA) which provide high-precision heading and attitude information are stored in ".N2R" data files.
3) DGPS system (Trimble SPS751 & StarFixXP) providing position fixes.
4) We used VmDas version 1.4.2 (TRD Instruments) for data acquisition.
5) To synchronize time stamp of pinging with GPS time, the clock of the logging computer is adjusted to GPS time every 1 minute.
6) The sound speed at the transducer does affect the vertical bin mapping and vertical velocity measurement, is calculated from temperature, salinity (constant value; 35.0 psu) and depth (6.5 m; transducer depth) by equation in Medwin (1975).

Data was configured for 16-m intervals starting 23-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 in Table 5.22-1.

(4) Preliminary results

Figures 5.22-1and 5.22-2 show time series plot of current U/V vector during stationary observation.

(5) Data archive

These data obtained in this cruise will be submitted to the Data Management Group (DMG) of JAMSTEC, and will be opened to the public via JAMSTEC home page.

(6) Remarks (Times in UTC)

The observation was carried out within following periods,

Leg1: 12:07 25th Sep. 2011 to 00:03 26th Oct. 2011

Leg2: 00:00 29th Oct. 2011 to 03:03 1st Dec. 2011

Table 5.22-1 Major parameters

Environmental Sensor Commands	
EA = +04500	Heading Alignment (1/100 deg)
EB = +00000	Heading Bias (1/100 deg)
ED = 00065	Transducer Depth (0 - 65535 dm)
EF = +001	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 = 10200010	Sensor Source (C; D; H; P; R; S; T; U)
	C (1): Sound velocity calculates 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
	U (0): Manual EU
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 count)
WB = 1	Mode 1 Bandwidth Control (0=Wid, 1=Med, 2=Nar)
WC = 120	Low Correlation Threshold (0-255)
WD = 111 100 000	Data Out (V; C; A; PG; St; Vsum; Vsum^2;#G;P0)
WE = 1000	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 = 40	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 = 0390	Mode 1 Ambiguity Velocity (cm/s radial)

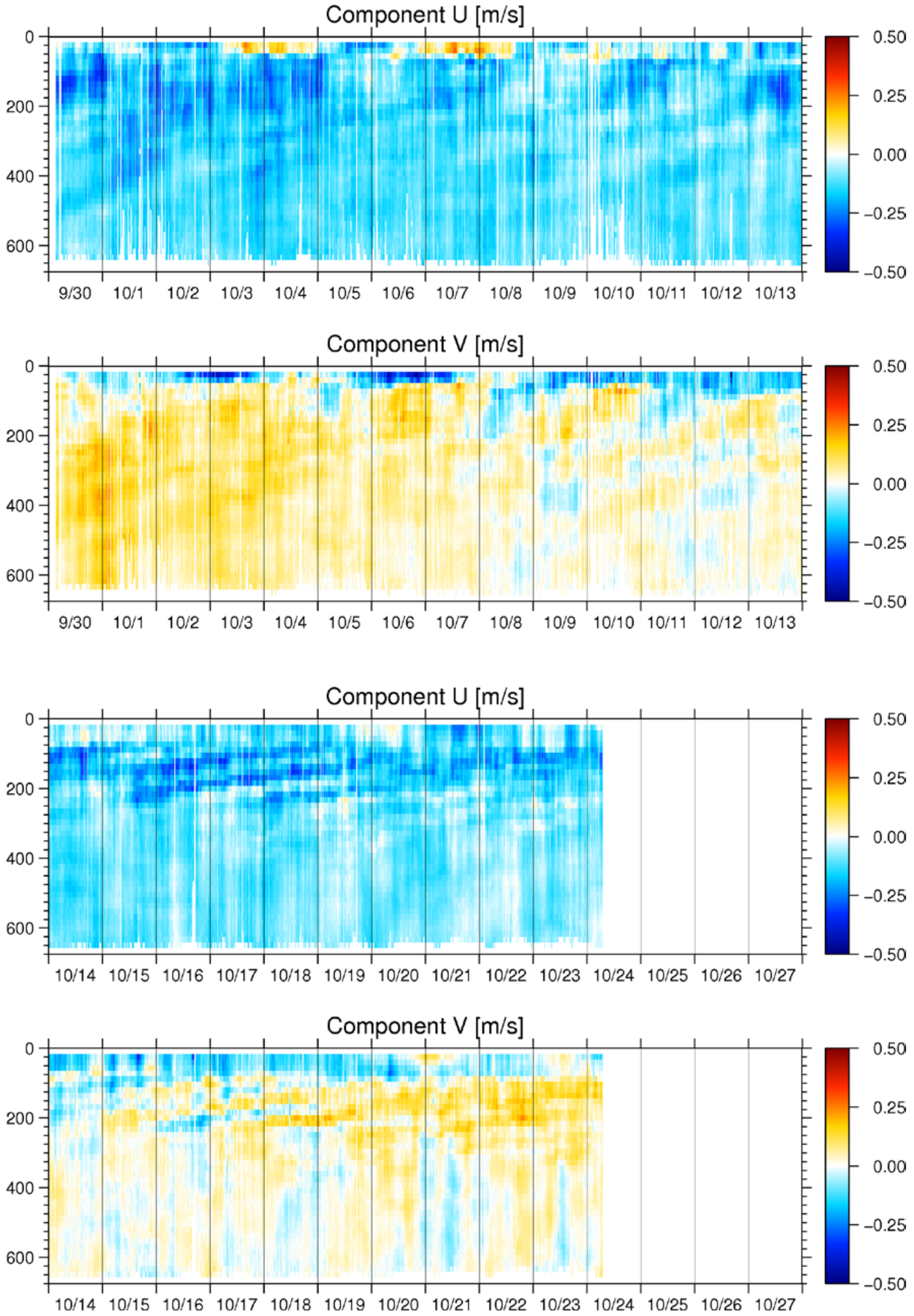


Fig 5.22-1: Time series plot of zonal and meridional current during stationary observation in Leg-1.

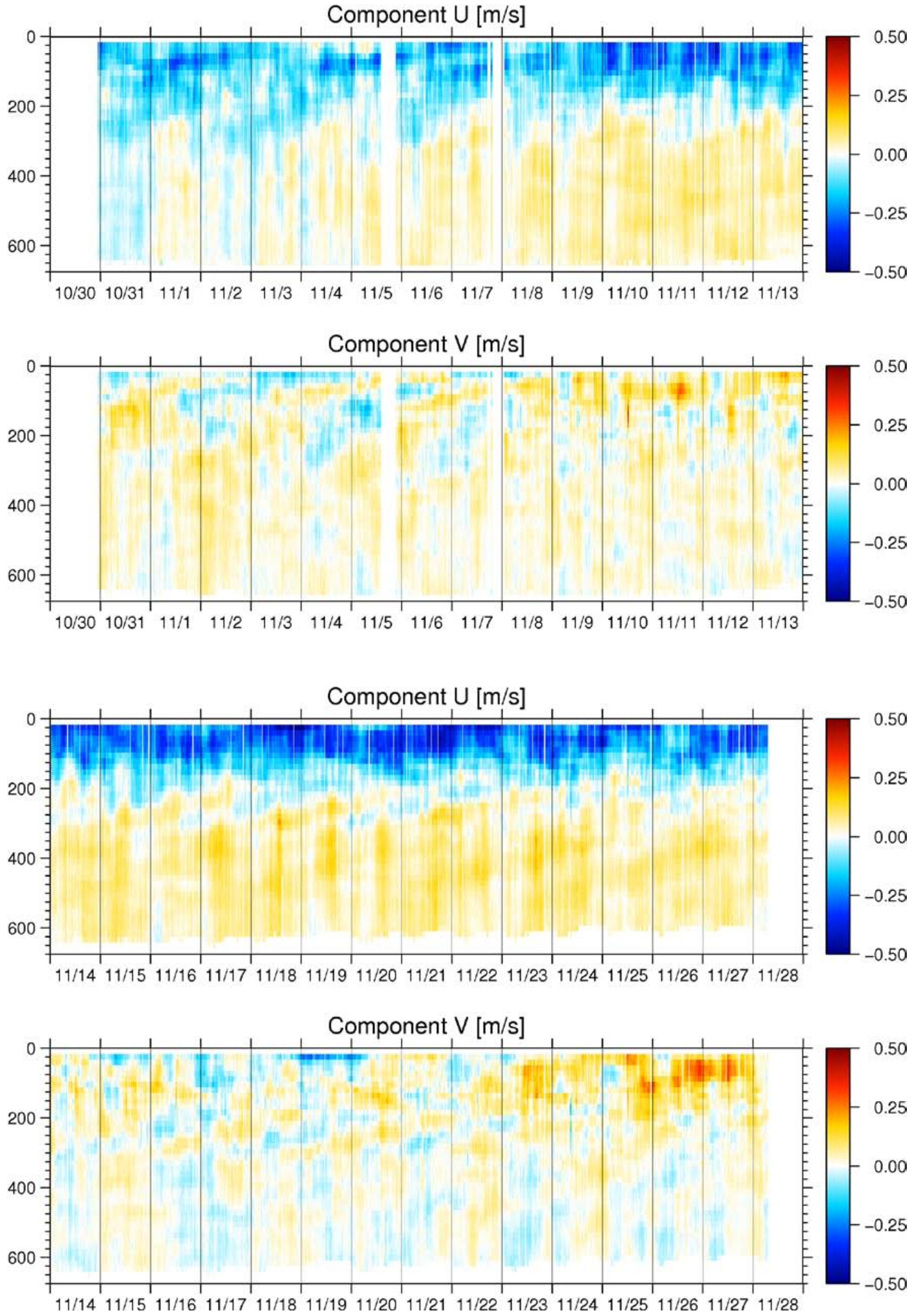


Fig 5.22-2: Time series plot of zonal and meridional current during stationary observation in Leg-2.

5.23 XCTD

(1) Personnel

Masaki KATSUMATA (JAMSTEC) - Principal Investigator (Leg-2)
Kazuaki YASUNAGA (JAMSTEC)
Souichiro SUEYOSHI (GODI) - Operation Leader (Leg-2)
Satoshi OKUMURA (GODI)
Kazuho YOSHIDA (GODI)
Asuka DOI (GODI)
Toshimitsu GOTO (GODI)
Wataru TOKUNAGA (MIRAI Crew)

(2) Objective

The objective of XCTD (eXpendable Conductivity, Temperature & Depth profiler) observation in this cruise is to obtain the spatial structure of the ocean, especially for the meridional cross section in the south of equator along 80E.

(3) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 (manufactured by Tsurumi-Seiki Co.). The signal was converted by MK-130 (Tsurumi-Seiki Co.) and was recorded by MK-130 software (Ver.3.07) (Tsurumi-Seiki Co.). The specifications of the measured parameters are as in Table 5.23-1. We launched 14 probes by using automatic launcher during Leg-2 as listed in Table 5.23-2.

Table 5.23-1: The range and accuracy of parameters measured by XCTD-1.

Parameter	Range	Accuracy
Conductivity	0 ~ 60 [mS/cm]	+/- 0.03 [mS/cm]
Temperature	-2 ~ 35 [deg-C]	+/- 0.02 [deg-C]
Depth	0 ~ 1000 [m]	5 [m] or 2 [%] (either of them is major)

(4) Preliminary results

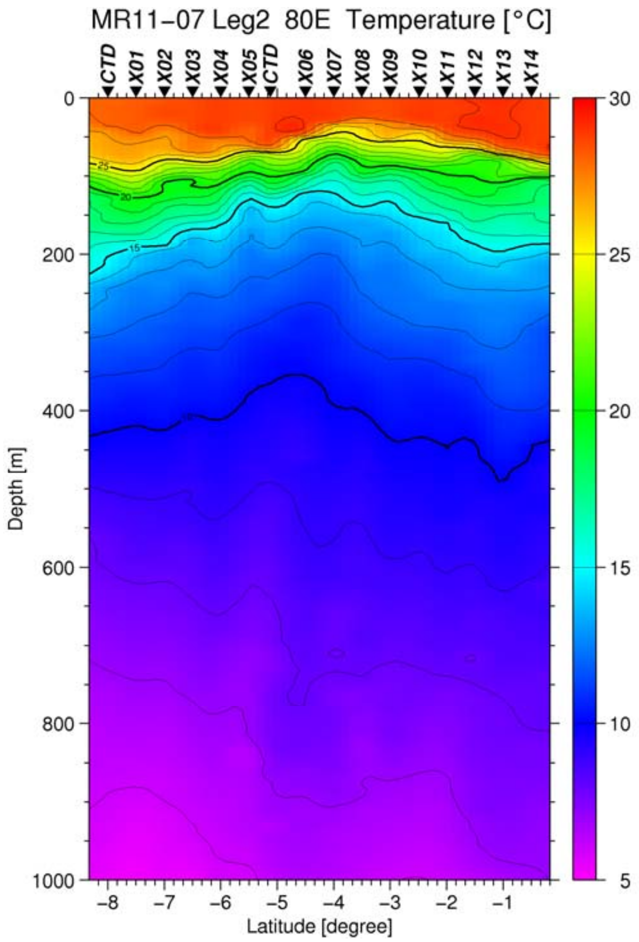
The vertical cross section along 80E on Nov.28-30 is displayed in Fig. 5.23-1. The “ridge” of the thermocline could found around 4S.

(5) Data archive

All data during this cruise will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG). The corrected datasets will be available at Mirai website at http://www.jamstec.go.jp/cruisedata/mirai/e/, and CINDY website.

Table 5.23-2: List of XCTD observations. SST (sea surface temperature) and SSS (sea surface salinity) at each launch are obtained by TSG (Section 5.13).

No.	Station	Date	Time	Latitude [dd-mm]	Longitude [dd-mm]	SST [deg-C]	SSS [PSU]	Probe S/N
X01	07-30S	2011/11/28	10:21	07-30.0495S	080-03.2303E	28.207	33.822	11063518
X02	07-00S	2011/11/28	12:59	06-59.9613S	079-38.5229E	28.458	33.717	11063519
X03	06-30S	2011/11/28	15:32	06-29.9337S	079-14.2016E	28.518	33.857	11079677
X04	06-00S	2011/11/28	18:23	05-59.9875S	078-49.7507E	28.653	33.883	11053320
X05	05-30S	2011/11/28	21:25	05-29.9931S	078-25.5407E	28.686	34.031	10079678
X06	04-30S	2011/11/29	17:09	04-30.0259S	078-19.0458E	28.974	34.201	11053316
X07	04-00S	2011/11/29	19:27	03-59.9417S	078-30.1535E	28.813	34.137	11053314
X08	03-30S	2011/11/29	21:38	03-30.0843S	078-41.2622E	28.664	34.047	11053313
X09	03-00S	2011/11/29	23:50	02-59.9457S	078-53.0346E	28.603	34.133	11053310
X10	02-30S	2011/11/30	02:03	02-29.0071S	079-04.2896E	28.874	34.401	11053317
X11	02-00S	2011/11/30	04:13	01-58.9488S	079-15.5740E	28.864	34.537	11053318
X12	01-30S	2011/11/30	06:19	01-29.7614S	079-26.4358E	29.153	34.648	11053309
X13	01-00S	2011/11/30	08:29	01-00.0104S	079-39.0446E	29.225	34.803	11053312
X14	00-50S	2011/11/30	10:40	00-30.0179S	079-50.3295E	28.908	35.062	11053315



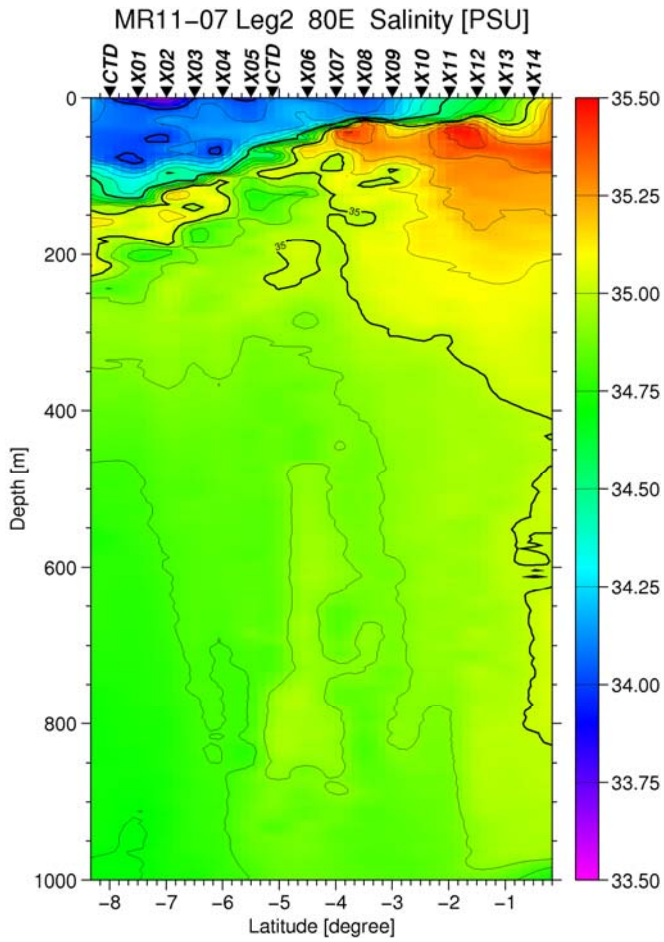


Fig.5.23-1: Vertical cross sections of the temperature (left) and the salinity (right) along 80E at Nov.28-30, 2011, obtained by combining XCTD and CTD observations (Section 5.14).

5.24 Argo-type float

(1) Personnel

Masaki KATSUMATA	(JAMSTEC)	- Principal Investigator
Hiroyuki YAMADA	(JAMSTEC)	- not on board
Shungo OSHITANI	(MWJ)	

(2) Objective

The objective is to measure the vertical profiles of sea-water temperature and salinity for investigating oceanic mixed layer structure and tropical air-sea interaction.

(3) Method

One NEMO-type Argo float (serial number of 203, WMO code of 2901671) was deployed at (5.1S, 78.1E) in the beginning of Leg-1 (see Table 5.24-1 and Fig. 5.24-1). This float measures the vertical profiles of sea-water temperature and salinity above 500db every 24 hours. It uses the Iridium transmitter to send observational data via satellite.

(4) Results

The vertical profiles of sea-water temperature and salinity, measured by NEMO-203 float are shown in Fig.5.24-2. These profiles are marked by a variation of temperature and salinity in the mixing layer (with depth of ~ 50 dbar) in a monthly timescale. Although the parking depth was not settled in a proper position (500 mbar) until 14 October, it was fixed by sending commands about modifying piston counting via the Iridium telecommunication system.

(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 5.24-1 Deployments of the floats

Type	Serial Number	Date (YYY/MM/DD)	Time (UTC)	Latitude	Longitude	Type
NEMO	203	2011/09/29	08:59	05-06.69S	78-06.70E	Iridium

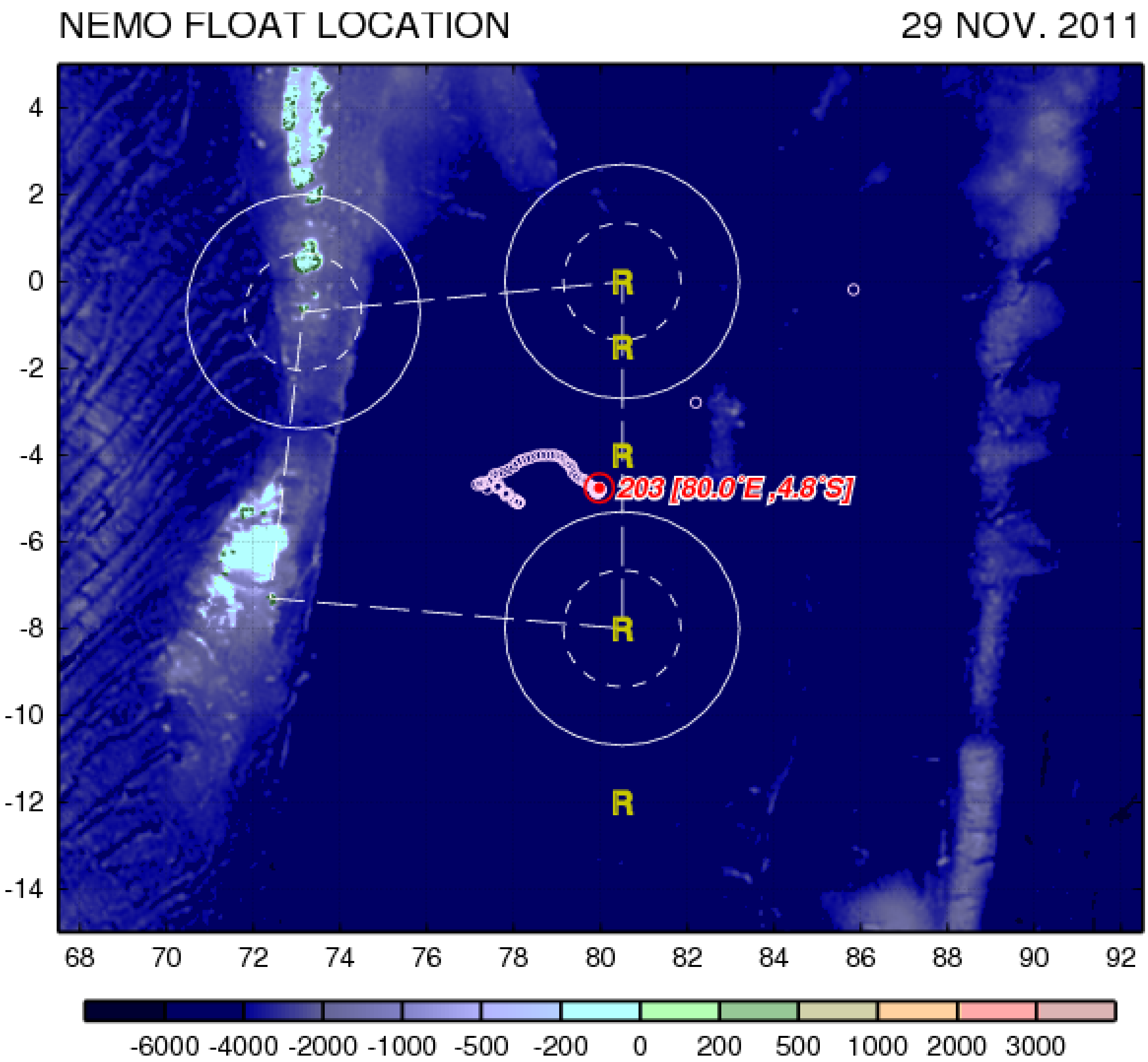


Fig. 5.24-1: The track of a NEMO-type Argo float until 29 November 2011. The latest position is marked by a red open circle with a dot. The labels "R" mean the location of RAMA mooring buoys while white open circles indicate the observational area of Doppler radars at Gan Island and on board R/V Mirai and R/V R. Revelle.

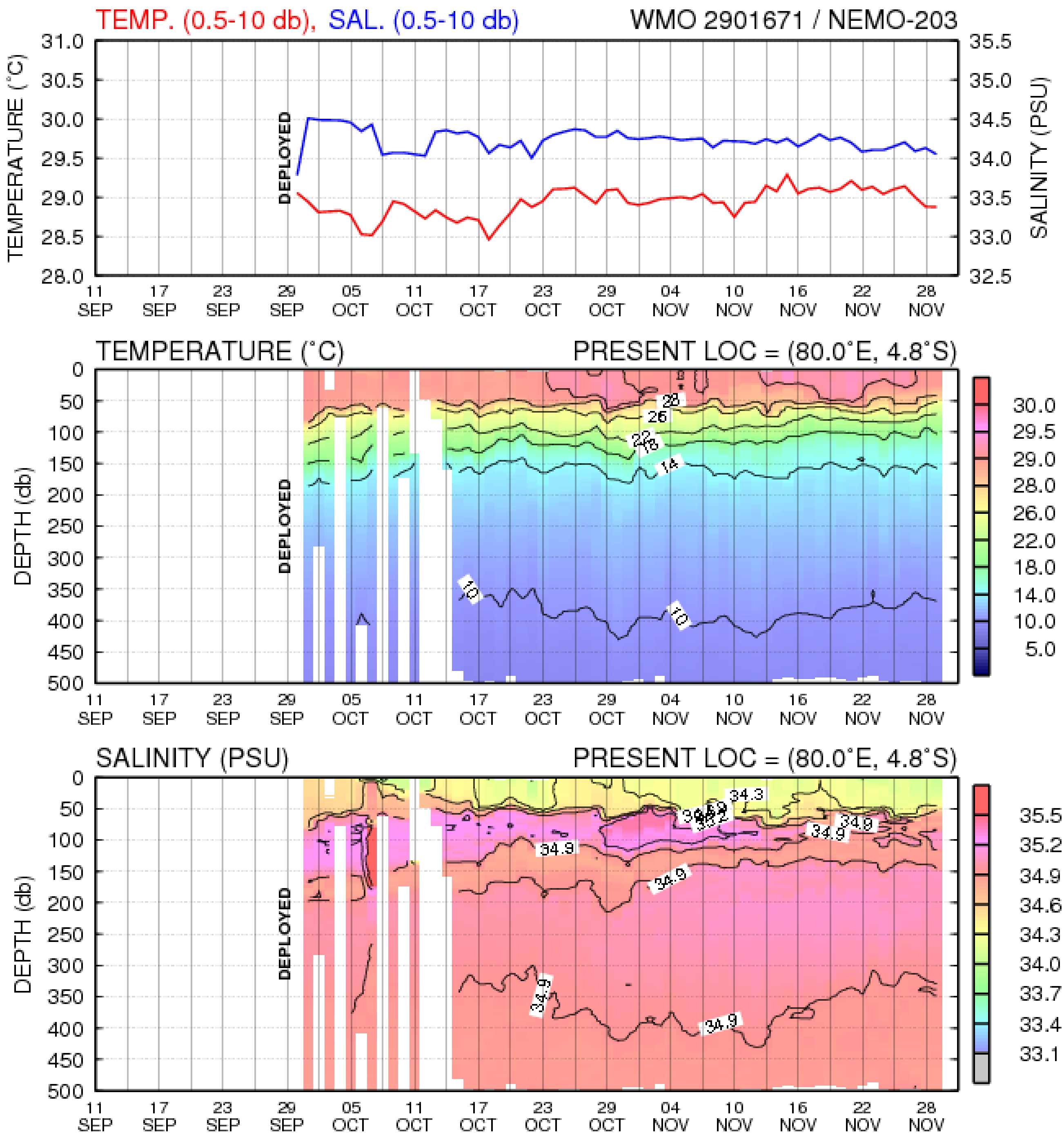


Fig. 5.24-2: (top) Time series of the temperature and salinity at the sea surface. (middle and bottom) Time-depth cross sections of sea-water temperature and salinity, observed by NEMO-203 float deployed on 29 November at 5.1°S, 78.1°E.

5.25 Subsurface buoy

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Masaki Katsumata ***	(JAMSTEC)	- Principal Investigator
Kunio Yoneyama*	(JAMSTEC)	
Shinsuke Toyoda*	(MWJ)	- Operation leader (Leg-1 [deployment])
Satoshi Ozawa*	(MWJ)	
Fujio Kobayashi*	(MWJ)	
Naoko Miyamoto*	(MWJ)	
Shungo Oshitani*	(MWJ)	
Yuki Miyajima*	(MWJ)	
Tomohide Noguchi**	(MWJ)	- Operation leader (Leg-2 [recovery])
Tetsuharu Iino**	(MWJ)	
Yasumi Yamada**	(MWJ)	
Miyo Ikeda**	(MWJ)	

(2) Objectives

The purpose of the subsurface buoy observation is to retrieve physical process underlying the dynamics of oceanic circulation in the Indian Ocean. In this cruise (MR11-07), we deployed subsurface mooring at 5S-78E in the beginning of Leg-1 and recovered the subsurface mooring in the end of Leg-2. Components of this mooring are depicted in Fig. 5.25-1.

(3) Methods

Three sensors are equipped on the mooring. Two are mounted at the top float of the mooring. One is ADCP (Acoustic Doppler Current Profiler) to observe upper-ocean currents from subsurface down to around 250m depths. The second instrument mounted below the float is CTD, which observes pressure, temperature and salinity for correction of sound speed and depth variability. The instrument “PAL (Passive Acoustic Listener)” is attached at 950-m depth, to measure the ocean acoustics to observe rainfall and wind speed at the ocean surface.

Details of the instruments and their parameters are as follows:

1) ADCP

Self-Contained Broadband ADCP 150 kHz

(Teledyne RD Instruments, Inc., Serial Number : 1155)

Distance to first bin: 8 m

Pings per ensemble: 16

Time per ping: 2.00 seconds

Bin length: 8.00 m

Sampling Interval: 1800 seconds

2) CTD

SBE-16

(Sea Bird Electronics Inc., Serial Number : 1279)

Sampling Interval: 1800 seconds

3) PAL

Passive Acoustic Listener

(Applied Physics Laboratory, University of Washington, Serial Number : 376004)

Frequency Range: 100 to 50000 Hz

Sampling interval: variable (records only when valid data was detected).

4) Other instrument

Acoustic Releaser

(BENTHOS, Inc., Serial Number : 666 and 667)

(4) Deployment

The ADCP mooring deployed at 5S-78E was planned to settle the ADCP at about 250-m depth. After we dropped the anchor, we monitored the depth of the acoustic releaser. As a result, the position of the mooring (No. 110929-05S078E) was obtained as follows:

Date:	29 Sep. 2011
Lat:	05-05.39S
Long:	078-05.56E
Depth:	4,989m

(5) Recovery

We recovered the ADCP mooring we deployed. The raw data from ADCP and CTD were recovered and converted into ASCII format. Results were shown as Figs. 5.25 -2 (for ADCP) and 5.25-3 (for CTD). The data from PAL will be recovered and converted after the cruise.

(6) Data archive

All data will be submitted to JAMSTEC Data Management Office.

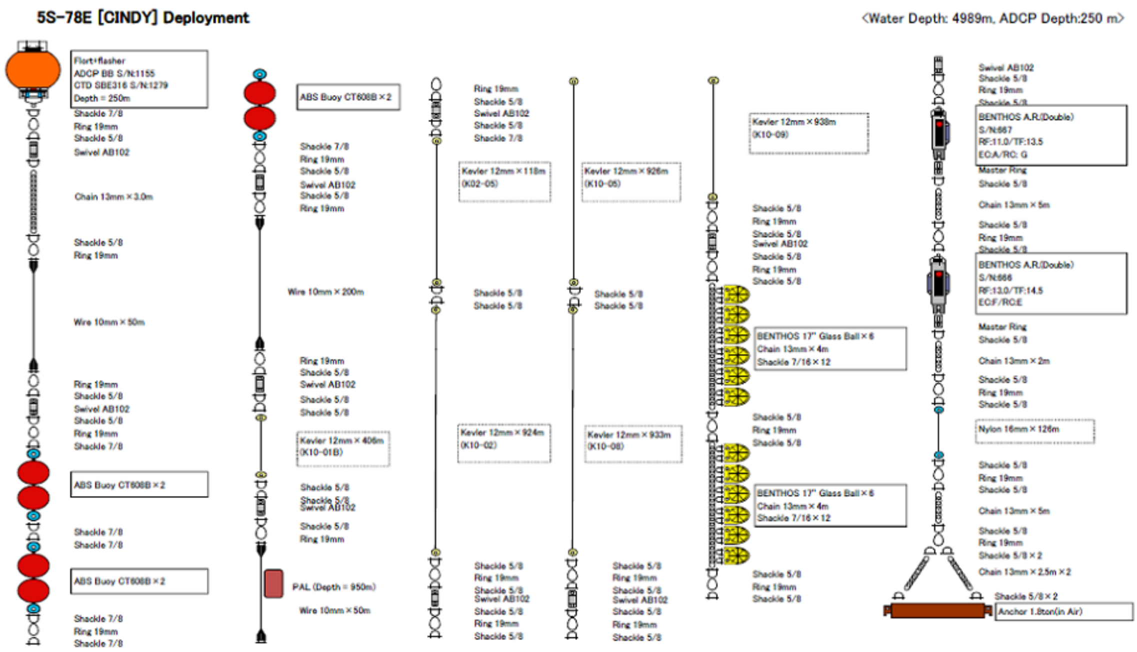


Fig.5.25-1 Mooring diagram.

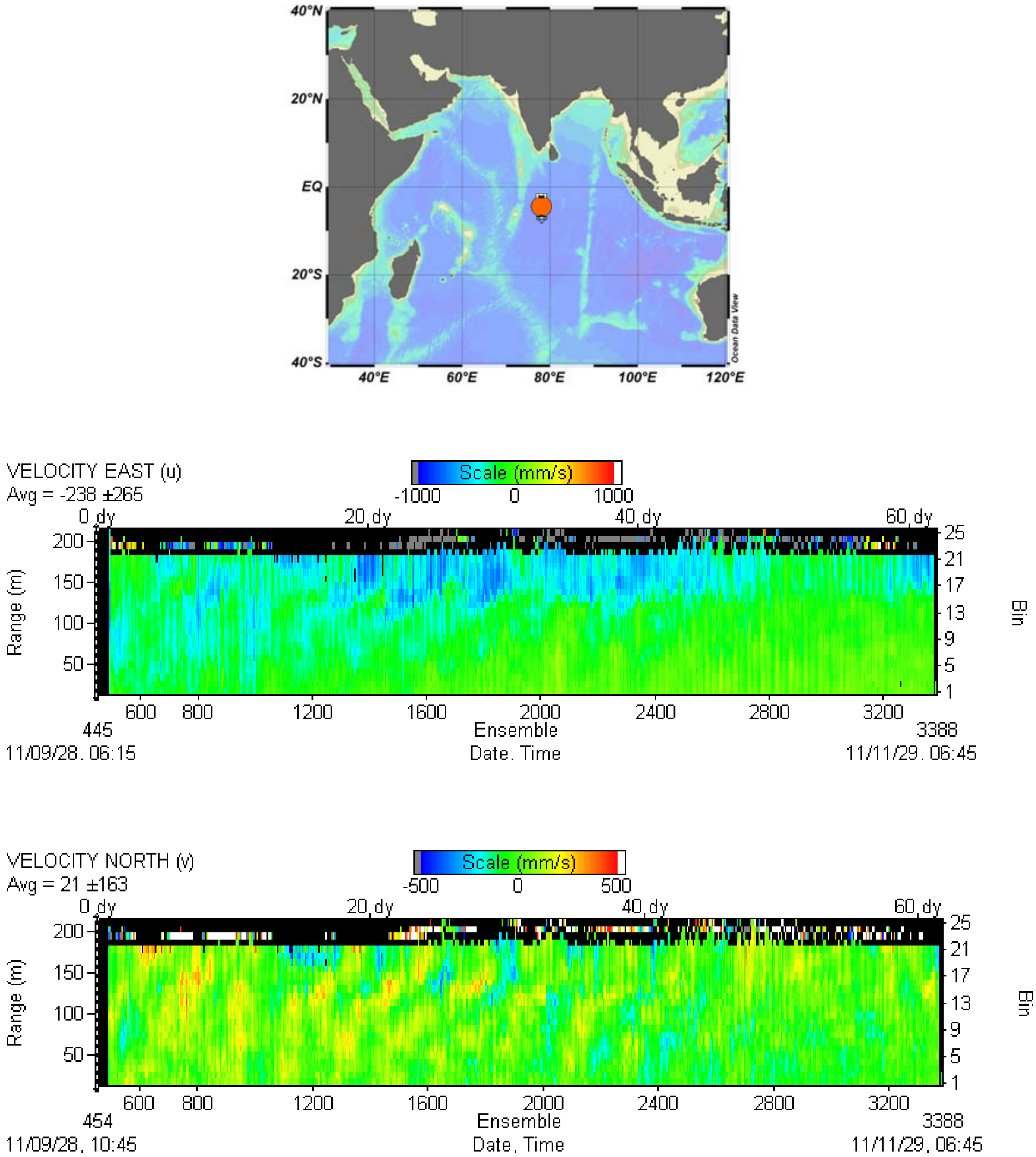


Fig. 5.25-2 Time Series of vertical profiles of zonal and meridional velocities obtained by the ADCP during mooring (Sep.29 to Nov.29, 2011)

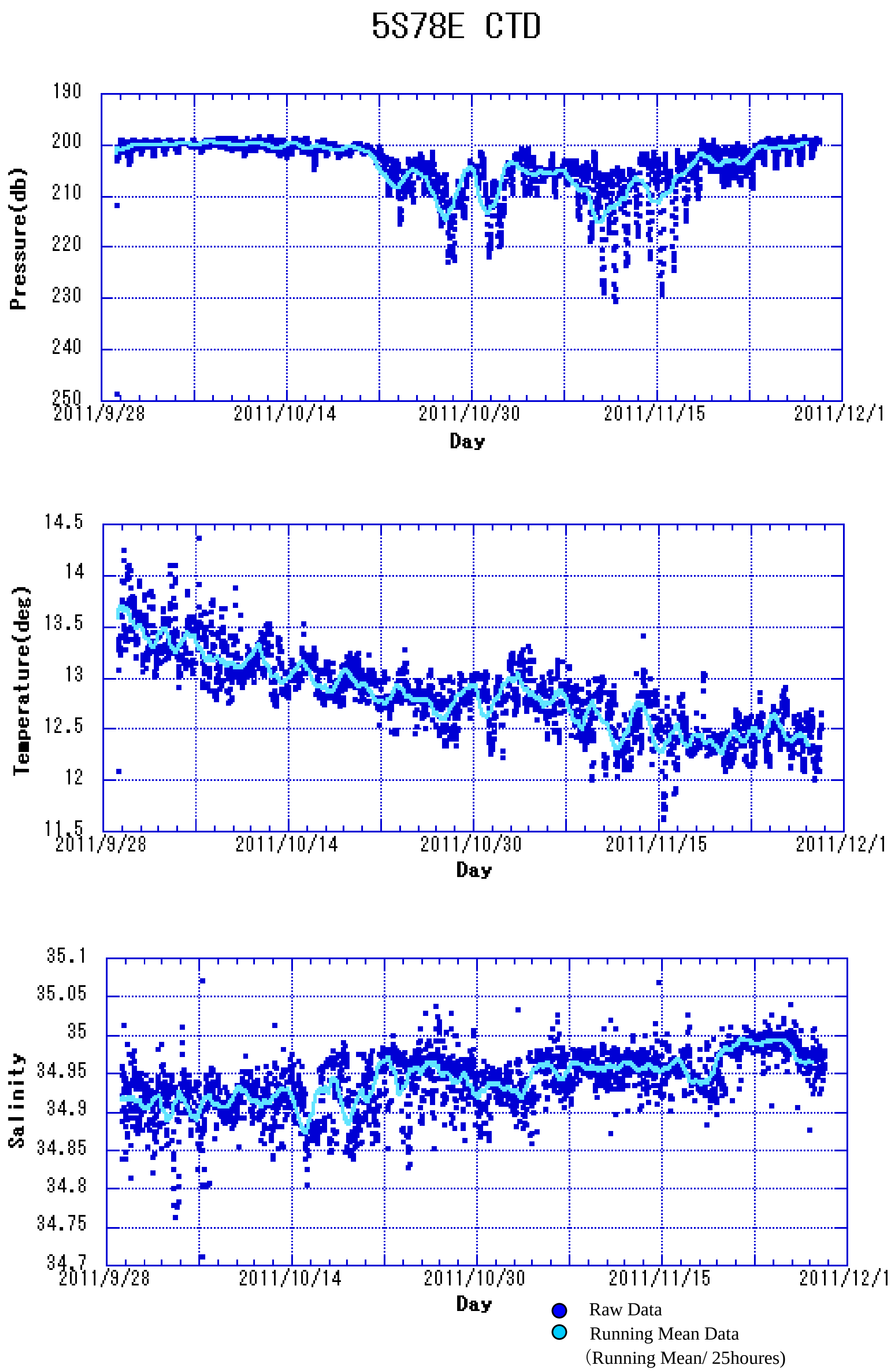


Fig. 5.25-3 Time Series of pressure, temperature, salinity obtained by the CTD during the mooring (Sep.29 to Nov.29, 2011)

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5.26 Distribution and ecology of oceanic *Halobates* and their responce to environmental factors

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Tetsuo HARADA*	(Kochi Univ.)	- Principal Investigator
Takero SEKIMOTO***	(Kochi Univ.)	
Yuki OSUMI***	(Kochi Univ.)	
Takashi SHIRAKI*	(Kochi Univ.)	
Akane KOBAYASHI*	(Kochi Univ.)	

(2) Introduction and Objectives

Many great voyages were launched to explore the oceans and what lies beyond, because they have always held a great fascination to us. A great variety of marine organisms were collected and describe during these voyages, but insects appear to have received little attention (Andersen & Chen, 2004). Although they are the most abundant animals on land, insects are relatively rare in marine environments (Cheng, 1985). However, a few thousand insect species belonging to more than 20 orders are considered to be marine (Cheng & Frank, 1993; Cheng, 2003). The majority of marine insects belong to the Coleoptera, Hemiptera, and Diptera, and they can be found in various marine habitats. However, the only insects to live in the open ocean are members of the genus *Halobates*, commonly known as sea-skaters. They belong to the family Gerridae (Heteroptera), which comprises the common pond-skaters or water-striders. Unlike most of its freshwater relatives, the genus *Halobates* is almost exclusively marine. Adults are small, measuring only about 0.5 cm in body length, but they have rather long legs and may have a leg span of 1.5 cm or more except for a new species, *Halobates megamoomario*. This new species which has very long boy length of 0.9 cm and large mid-leg span of 3.2 cm has been newly and recently collected in the tropical Pacific Ocean during the cruise, MR-06-05-Leg 3, and described (Harada et al., submitted). They are totally wingless at all stages of their life cycle and are confined to the air-sea interface, being an integral member of the pleuston community (Cheng, 1985). One may wonder how much tiny insects have managed to live in the open sea, battling waves and storms. In life, sea-skaters appear silvery. On calm days ocean-going scientists have probably seen them as shiny spiders skating over the sea surface. It is not known whether ancient mariners ever saw them, and no mention of their presence has been found in the logs of Christopher Columbus'S (1451-1506) ships or other ships that sailed to and from the New World (Andersen & Cheng, 2004).

Forty-seven species of *Halobates* are now known (Andersen & Cheng, 2004; Harada *et al.*, submitted). Six are oceanic and are widely distributed in the Pacific, Atlantic and the Indian Oceans. The remaining species occur in near-shore areas of the tropical seas associated with mangrove or other marine plants. Many are endemic to islands or island groups (Cheng, 1989).

The only insects that inhabit the open sea area are seven species of sea skaters: *Halobates micans, H. sericeus, H. germanus, H. splendens, H. sobrinus* (Cheng, 1985) and new oceanic species of *H. princeps* and *H. moomario* (proposed new species: Harada & Sekimoto, prepared) under description (Harada *et al.*, submitted). Three species, *Halobates sericeus*, *H. micans* and *H. germanus* inhabit tropical and temperate areas of the Pacific Ocean in the northern hemisphere, including The Kuroshio Current and the East China Sea (Andersen & Polhemus, 1976, Cheng, 1985). *Halobates sericeus, H. micans and H germanus* are reported from latitudes of 13ºN-40ºN, 0ºN-35ºNand 0ºN-37ºN, respectively, in the Pacific Ocean (Miyamoto & Senta,,1960; Andersen & Polhemus, 1976; Ikawa *et al.*, 2002). However, this information was collected on different cruises and in different times of the years. There have been several ecological studies based on samples collected in a specific area in a particular season during the six cruises of R/V HAKUHO-MARU: KH-02-01, KH-06-02, TANSEI-MARU: KT-07-19, KT-08-23 and R/V MIRAI: MR-06-05-Leg 3, MR-08-02.

During one cruise, KH-02-01, one sea skater species, *Halobates sericeus,* was collected at 18 locations in

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the East China Sea area (27°10' N- 33°24' N, 124º57' E - 129º30' E) (Harada, 2005), and *H. micans* and/or *H. germanus* at only 8 locations in the area south of 29° 47'N, where water temperatures were more than 25℃. At three locations, where the water temperature was less than 23℃, neither *H. micans* nor *H. germanus* were caught.

During another cruise, KH-06-02, in the latitude area of 12° N to 14° 30' N, *Halobates micans* were caught at 6 of 7 locations, while *H.germanus* and *H. sericeus* were caught at only 3 and 1 location(s), respectively (Harada *et al,* 2006). However, at 15° 00' N or northern area, *H. germanus* were caught at 14 of 19 locations, whereas *H. micans* and *H. cericeus* were caught at only 8 and 6 locations, respectively (Harada *et al*, 2006).

In the cruise, MR-06-05-Leg 3, larvae of both *H. micans* and *H. germanus* were very abundant at 6º N, whereas adults of *H. germanus* alone were completely dominant at 2º N on the longitudinal line of 130ºE. On the longitudinal line of 138ºE, larvae and adults of *H. micans* alone were dominant at points of 5 º and 8ºN, while adults of *H. germanus* were abundant between 0º and 2ºN. At the two stations of St. 37 (6º N, 130º E) and St. 52 (5º N, 138º E), relatively great number of larvae of *H. sericeus* were collected. This species has been known to be distributed in the northern area of the Pacific Ocean. At St. 52 (6º N, 138º E), it was heavily raining around the ship while trailed.

In the cruise, KT-07-19 on the northern edge of Kuroshio Current, *H. sericeus* was mainly collected in the northern-eastern area of 135º-140ºE, 34º-35ºN whereas *H. germanus and H. micans* were mainly collected in the relatively southern-western area of 131º-133ºE., 31º-33ºN. Only *H. sericeus* can be transferred by the Kuroshio Current onto the relatively northern-eastern area and to do reproduce at least in the summer season. In the cruise of KT-08-23, Most of “domestic” specimen collected in the area northern to Kuroshio current and near to Kyushu and Shikoku islands in September were *H. germanus* (Harada *et al.*, submitted).

All samplings of *Halobates* have been performed at different geographical positions in any cruise in the Pacific Ocean so far. However, there has been no information on the dynamics in species and individual compositions in relatively eastern area of 145-160ºE, 0-10ºN of tropical Pacific Ocean. This study aims, first, to perform samplings in this area of the Western Pacific Ocean and examine dynamics of the species composition and reproductive and growth activity and compare these data to the data in the past which were got in more western area of 130-137ºE, 0-10ºN in the cruise, MR-06-05- Leg 3 (Harada *et al.,* 2007; Harada *et al*., 2011a).

During the cruise, MR-08-02, on the longitudinal line of 130ºE, larvae of both *H. micans* and *H. germanus* were very abundant at 5-12º N, whereas adults of *H. sericeus* alone were dominant at 17º N. In the lower latitude area of 5-8 º N, all the three described species, *H. micans, H. germanus* and *H. sericeus* and un-described species, *Halobates moomario* (Harada & Sekimoto, prepared) were collected. At a fixed point located at 12ºN, 135ºE, *H. micans* was dominant through the sampling period of 20 days, whereas *H. sericeus* was collected mainly in the latter half of the period. Higher number of *Halobates* (593) was collected in the first half of the sampling period (8th – 17th June, 2008) when the weather was very fine than that (427) in the second half (18th – 27th June, 2008) when the typhoon No 6 was born and developed near the fixed sampling point.

In this cruise of MR-09-04, on the longitudinal line of 155-156ºE *H. germanus* was very dominant, whereas three adults of *H. micans*, *H. germanus* and *H. sericeus* were dominant at 5º N on the longitudinal line of 147 ºE during this cruise held in Nov 4-Dec 12, 2009 (Harada *et al.*, 2009; Harada *et al.,* 2010a). Among several latitudes of 0-10 º N, peak of number of individuals collected was located at 8 º N, 5 º N and 0-2 º N for *H.m., H.g.* and *H.s.,* respectively, on the longitudinal line of 155-156 º E. From latitudinal point of view, *H. micans* and *H.germanus*. were abundant in 5-8 º N, whereas *H. sericeus* and *H. moomario* were in 0-5 º N. Except for St. 6 at 3 º N, 147 º E, more than half of specimen collected were larvae at the remaining St. 1-5 and St.7,8.. Un-described new species, *Halobates moomario* was mostly on the longitudinal line of 147ºE. On the

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longitudinal line of 147 º E, more newly hatched larvae were collected than those on the line of 155-156E. *Halobates micans* was dominantly inhabiting at a fixed point of 3N, 139E in the tropical Pacific Ocean during a science cruise of MR-10-03 administered in May and June of 2010.

In the cruise, KH-10-04-Leg. 1 (Harada *et al.*, 2010b), the samplings of *Halobates* inhabiting temperate and subtropical Pacific Ocean along the cruise track from Tokyo to Honolulu for the 2 weeks showed that four species of *Halobates micans, H.germanus, H. sericeus, H. moomario* inhabited in the relatively northern and western area of 30ºN-34ºN and 140ºE-144ºE, although *H. sericeus* was dominant species. In the relatively southern and eastern area of 19 ºN-29ºN and 147ºE-163ºW, only *H. sericeus* was exclusively inhabiting. Many larvae of this species were collected through all the stations and the reproductive activity of *H. sericeus* seems to be active in this area. Significantly more female-adults were collected rather than male-adults in total (χ^2-test, P<0.01). The extent of positive phototaxis by females may be higher than that of males, or avoiding behavior from the opening of the Neuston Net might be more active by males than females.

In the cruise, KH-10-04-Leg 2(Harada *et al.*, 2010c), the samplings of *Halobates* in Central or Eastern Tropical Pacific Ocean showed that *Halobates sericeus* was dominant at 13º59'N, 162º06'W, while *Halobates megamoomario* and *Halobates moomario* were dominant in the areas of 2º35'N-2º45'N, 164ºW-166ºW and 14ºN-17ºN, 172ºW-176ºW, respectively. In the sampling area of the Central or Eastern Tropical Pacific ocean, the population density of *Halobates* is relatively low of 3626.4/km^2.

In the cruise, KH-10-05-Leg 1 (Harada et al., 2010d), the samplings of *Halobates* in Tropical Indian Ocean showed that *Halobates micans* was dominant with estimated population density of about 58000 individuals/km^2 along the cruise track from 04'09S, 094'26E to 08˚40'S, 084˚04'E, while *H. micans* was also dominant but estimated population density was relatively low of 0 -21523 /km^2 on the line of cruise track from 10˚12'S, 080˚24'E to 15˚23'S, 067˚48'E. Positive and negative correlations were shown between chlorophyll conc. and the number of *Halobates* (mostly *H. micans*) individuals collected and between oxygen and the number of sea skaters inhabiting in Tropical Indian Ocean, respectively.

This study aims, first, to examine the relationship between the individual number and species components of the oceanic sea skaters of *Halobates* micans (Heteroptera: Gerridae) and *H. germanus* and oceanic dynamism on several factors like as precipitation, waves, air temperature, chlorophyll conc. and dissolved oxygen conc. in surface water during 2 months of sampling- and examination-period at the fixed point of 8ºN,80ºE in Tropical Indian Ocean during the science cruise, MR-11-07 which is participation of CYNDY2011 (Cooperative Indian Ocean experiment on intra-seasonal variability in the Year 2011) an international project on the other hand.

Fresh water species in Gerridae seem to have temperature tolerance from -3℃ to 42℃ (Harada, 2003), because water temperature in fresh water in ponds and river highly changes daily and seasonally. However, water temperatures in the ocean are relatively stable and only range from 24℃ to 30 ℃ in the center of Kuroshio current in southern front of western Japan (Harada, 2005). Adults of *Halobates germanus* showed semi-heat-paralysis (SHP: static posture with no or low frequency to skate on water surface), when they were exposed to temp. higher than 32℃ (Harada unpublished, data in the TANSEIMARU cruise: KT-05-27).

In contrast to the temperate ocean, water temperature in the tropical ocean area, is more stable around 30℃. Therefore, the tropical species of *H. micans* is hypothesized to have lower tolerances to temperature changes than the tropical-temperate species, *H. sericeus*. This hypothesis was true in the laboratory experiment during the cruise of KH-06-02-Leg 5 (Harada *et al.*, submitted). When the water temperature increased stepwise 1℃ every 1 hour, heat-paralysis (ventral surface of thorax attaché to water surface and unable to skate) occurred at 29℃ to >35 ℃ (increase by 1 to >7 ℃). Three of four specimens in *Halobates sericeus* were not paralyzed even at 35 ℃ and highly resistant to temperature change, while only one of nine in *H. micans.* and only four of twelve in *H. germanus* were not paralyzed at 35 ℃. On average, *H. sericeus, H germanus and H. micans* were paralyzed at >35.6 ℃ (SD: 0.89), >32.9 ℃(SD: 2.17) and >31.6 ℃ (SD: 2.60) on average,

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respectively (Harada *et al.*, submitted).

As an index of cold hardiness, super cooling points (SCPs) have been used in many insects (Bale, 1987, 1993; Worland, 2005). The absence of ice-nucleating agents and/or the lack of an accumulation of cryo-protective elements can often promote higher super cooling points (Milonas & Savopoulou-Soultani, 1999). SCPs, however, might be estimated as only the lower limits of super cooling capacity and only a theoretical lower threshold for the survival of insects as freeze-non-tolerant organisms. Many insects show considerable non-freezing mortality at temperatures well above the SCPs, a "chill-injury" species (Carrillo *et al.*, 2005; Liu *et al.*, 2007). Liu *et al* (2009) recently showed that SCPs change in accordance with the process of winter diapauses, decreasing in Dec-Feb and increasing rapidly in Feb-Apr (diapauses completing season) due to making glycogen from trehalose as a "blood suger" leading to lower osmotic pressure in haemolymph due to low "trehalose" level. This relation supports the possibility of SCPs available as an indirect indicator of cold hardiness of insects.

The 0-10ºN latitude-area in the Pacific Ocean has very complicated dynamic systems of ocean and atmosphere. Because of such complicated system, water/air temperatures and water conductivity (salinity) can be in dynamic change temporally and spatially. Sea skaters inhabiting this area of the Pacific Ocean show relatively high tolerance to temperature changes (heat tolerance) (Harada *et al.,* 2011a), and *H. sericeus* which is inhabiting wide latitude area of 40ºN-40ºS in the Pacific Ocean is more hardy to temperature increase than other two oceanic sea skaters, *H. germanus* and *H. micans* inhabiting narrower latitude range of 25ºS-25ºN and 20ºS-20ºN in the Indian and Pacific Ocean (Harada *et al.*, 2011a). Adult specimens of *Halobates micans* living at 6ºS, 89ºE where currents from south and north directions hit and get together than those living at other places of 8ºN, 89ºE in the tropical Indian Ocean (Harada *et al*., 2011b). Due to 3 or 4ºC of temperature decrease when rain falls, tolerance to high temperature by *H. micans* becomes weaker in the tropical Pacific Ocean (Harada *et al*., 2011b). Recently, a cross-tolerance to high and low severe temperature has been reported by fresh water species of semi-aquatic bug, *Aquarius paludum* (Harada *et al.*, 2010e). Also oceanic sea skaters (all four species of *H. micans, H. germanus, H. sericeus* and *H.sp.*) inhabiting tropical ocean showed a negative correlation between heat coma temperature and SCP (Harada *et al.*, 2009: the cruise report of MR-09-04). Similar correlation was also observed only for males of *H. sericeus* collected on the cruise track between Tokyo and Honolulu, Hawaii (Harada *et al.*, 2010b: the cruise report of KH-10-04-Leg 1).

This study aims, second, to examine whether sea skaters, living at the fixed point of 8S, 80S of the tropical Indian Ocean show a high cross tolerance of higher heat tolerance and lower super cooling points (SCP) and also to examine some relationship between SCP as a index of cold hardiness of sea skaters and oceanic dynamism on several factors like as precipitation, waves, air temperature, chlorophyll conc. and dissolved oxygen conc. in surface water.

Insects which have chance to be exposed to sea water or brackish water are known to adopt one of two strategies to survive an stress as higher osmotic pressure, "osmoregulating" and "osmoconforming" (Bradley, 1987). In the former strategy, insect maintains the osmotic pressure in haemolymph relatively lower level against high salinity environment. For example, dipteran larvae including saline-water mosquitoss of the genus *Aedes* and chironomids (Neumann, 1976; Kokkin, 1986) constantly lose water in saline water. To prevent water loss, larvae drink the external medium and at the same time excrete a concentrated "urine" to keep lower osmotic pressure in the haemolymph. In the latter strategy, osmoconforming, insects of other genera of mosquitoes (Bradley, 1987, 1994) and euryhaline species of other order genera (for example a dragon fly nymph, *Enallagma clausam*: Stobbart & Shaw, 1974) equilibrate the osmotic pressure of the haemolymph with that of the saline environment.

A semi-aquatic bug, *Aquarius paludum,* a fresh water and semi-cosmopolitan species in Palearctic area response to the exposure to the brackish water: the limit for nymph growth was 0.9% of NaCl, and even in 0.45% of salinity can depress the reproductive activity (down up to 2/3 of fecundity) in the population

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inhabiting fresh water habitat (Kishi *et al.*, 2006, 2007, 2009). How do oceanic sea skaters adapt to the brackish and fresh water environment? In the open ocean, some heavy rain can make the sea water file leading to rapid decreasing of osmotic pressure.

In the cruise of KH-09-05-Leg.7 (Harada & Sekimoto, 2010: the cruise report), Salinity experiment was performed at the first time on sea skaters of *Halobates* sp (under the description as *Halobates moomario*) inhabiting Tomini Bay in Indonesia. The movements of mid- and/or hind legs of all the specimen on the fresh water were paralyzed with unusual back position and quick fluctuating and all ones were dead within 2 hours after the occurrence of such so called "paralysis due to fresh-water shock" The paralysis and death after that occurred only on the fresh water 19-31hrs and 21-33 hrs, respectively. In total data from Experiments 1-3, females showed significantly longer hours of 27 hrs in survival on average than males only on the fresh. Individuals on 2/3 sea water tended to be in survival longer than those on 100% sea water in Experiments 1-3 (Wilcoxon test on average value: z= -1.604, p=0.109).

In the cruise of KH-10-04-Leg 2 (Harada *et al.*, 2010c: the cruise report), on the fresh water, the movements of mid- and/or hind legs of all the specimen on the fresh water were paralyzed with unusual back position and quick fluctuating just after transferring to the fresh water and all ones were dead within 2-3 hours after the transferring to the fresh water in all three species of *Halobates sericeus*, *H. moomario* and *H. megamoomario* inhabiting open Pacific Ocean. In the case of *H. moomario* inhabiting in Tomini bay, such fresh water paralysis occurred 15-20hours after the transferring to the fresh water. Sea skaters inhabiting the open Ocean may be less resistant to fresh water than those living on Tomini Bay, because there are no effects of fresh water flowing from the rivers of lands. Even on the salinity of 11‰, all the three species of sea skaters survived for similar hours to those on the higher salinity of 22-36‰. They can survive when they are exposed to the heavy rain and following very low salinity level of the surface layer of the sea.

In the cruise of KH-10-05 (Harada *et al*., 2010c: the cruise report), the fresh water shock occurred very quickly within 2-9hrs for in all adult specimens of *H. micans* from the Oceans and dead within 2hrs thereafter. Significantly longer hours in survival were shown by the both species on 1/3 or 2/3 sea water than those on sea water. The longer hours in survival by oceanic sea skaters to "brackish waters" could be speculated to be adaptation to the occasional rain fall on the sea water film.

As a third aim of this study, another experiment is performed on oceanic sea skaters, *Halobates micans and H. germanus* inhabiting the Indian Ocean to know an exact threshold of higher limit to trig the leg paralysis due to lower salinity which can be named "low salinity shock" . This experiment tries to clarify whether some relationship is between oceanic dynamics (for example, weather, precipitation, waves, salinity, air temperatures) in the day before the collection and survival days under several salinity levels and also the threshold to trig the "low salinity shock".

(3) Materials and Methods

Samplings

Samplings were performed in 27th September– 22nd October, 2011 with a Neuston NET (6 m long and with diameter of 1.3 m.)(Photo 1). The Neuston NET was trailed for 15 mm x 3 times on the sea surface at 17 stations in which 16 stations are around a point of 08º00'S, 080º30'E in tropical Indian Ocean on the starboard side of R/V MIRAI (8687t) which is owned by JAMSTEC (Japan Agency for Marine-earth Science and TECHnology). The trailing was performed for 15min exclusively at night with the ship speed of 2.0 knot to the sea water (Photo 1). It was repeated 2 times in each station. Surface area which was swept by Neuston NET was evaluated as a expression of [flow-meter value x 1.3m of width of the Neuston NET (Photo 1). All contents including sea skaters trapped in the pants (grey and plastic bottle (Photo 2) were transferred to a round-shaped transparent plastic aquarium (Photo 3). All sea skaters were picked up from the contents of the

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aquarium.

Laboratory experiment

The sea skaters trapped in the pants were paralyzed with the physical shock due to the trailing of the NET. Such paralyzed sea skaters were transferred on the surface of paper towel (Photo 4) to respire. Some individuals could recover completely from the paralysis. Then, the paralysis of some ones was discontinued within 20min. When sea skaters were trapped in the jelly of jelly fishes, the jelly was removed from the body of sea skaters very carefully and quickly by hand for the recovering out of the paralysis.

Adults and 3rd to 5th instars which recovered out of the paralysis were moved on the sea water in the aquarium set in the laboratory (Photo 5) for the Heat-Paralysis Experiments and measuring Super Cooling Points (Photo 6). Many white cube aquaria with 30cm X 30cm X 40cm) were used in the laboratory of the ship for rearing of the adults and larvae which were recovered out of the paralysis due to the trailing. Each aquarium contained ten to twenty adults and/or larvae of *Halobates*. Both the room temperature and sea water temperature in the aquaria were kept at 29±2℃. For about 9 hours after the collection, sea skaters were kept in the aquaria before the heat-paralysis experiment. All the individuals of *Halobates* which have been kept in the aquaria more than 12 hours after the collection were fed on adult flies, *Lucillia illustris.* When SCP was measured without being applied to heat coma experiment, specimen were kept starved more than 24 hours before the measurement. The transparent aquarium as the experimental arena has sea water with the same temperature (mostly 28 or 29℃) as that of the aquarium to keep sea skaters. 4 to 11 individuals at adult or larval stage were moved to the transparent aquarium. Temperature was stepwise increased by 1℃ every 1 hour till the high temperature paralysis occurring in all the experimental specimens. Four or five layers of cardboard were rapped around the round-shaped experimental aquarium and functioned as an insulator.

Temperature was very precisely controlled by handy on-off-switching to keep in ±0.3 ℃ of the current water temperature. Handy-stirring with 10cm air tube with 5mm diameter and ball stone with 3cm diameter was effective to keep the precise controlling of the current temperature. Sea skaters on the water surface of the aquarium were recorded with Digital Handy Video Camera (GZ-MG840-S: VICTOR) from above position for the last 10 min of each 1hour under the current temperature. Temperature at which Semi Heat Coma (Heat Semi-Coma Temperature [HSCT]: little or no movement on the water surface more than 3 seconds) occurs and another temperature at which Heat Coma (Heat Coma Temperature [HCT]: ventral surface of the body was caught by sea water film and no ability to skate any more) occurs were recorded.

Determination of super cooling point (SCP)

Measurements of super cooling points and increasing temperature value at the moment of an exothermic event occurred in the body of the specimen (ITSCP: increased temperature at SCP) were performed for the specimen (mainly adults) paralyzed by high temperature of the two species of oceanic *Halobates* (*H. micans, H. germanus*) just after the heat paralysis experiment during this cruise. Some actively skating specimens were directly applied to the measurements of SCP and ITSCP without heat paralysis experiment to detect the effect of heating during the experiment on SCP and ITSCP.

Surface of each adult was dried with filter paper, and thermocouples which consist of nickel and bronze were attached to the abdominal surface of the thorax and connected to automatic temperature digital recorders (Digital Thermometer, Yokogawa Co, LTD, Model 10, Made in Japan). The thermocouple was completely fixed to be attached to the ventral surface of abdomen by a kind of Scotch tape. The specimen attached to thermocouples was placed into a compressed-Styrofoam box ($5\times5\times3$ cm^3) which was again set inside another insulating larger compressed Styrofoam to ensure that the cooling rate was about 1ºC/min for recording the SCP in the freezer in which temperature was -35ºC. The lowest temperature which reached before an exothermic event occurred due to release of latent heat was regarded as the SCP (Zhao & Kang, 2000). All

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tested specimen were killed by the body-freezing when SCP was determined.

Salinity experiment

The fifth instars and adults of *H. micans* collected during this cruise, MR-11-07-Leg 2 were used for the salinity experiment. All specimen (mostly adults) for Experiment 1-3 were moved on the sea water in the aquaria set in the wet laboratory in R/V Mirai (temperature was kept within 30.0±2C). White cube aquaria with 30cm X 30cm X 40cm) (Photo 2) were used for the experiments. Experimental specimens were moved to one of the 6 salinity conditions, brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, A’: 9‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰).

All specimens were adults or 5th instars of *Halobates micans.* Experimental specimens were kept more than 24 hours within 1 week after the collection and fed on the flies, *Lucilia illustris* (rate of one fly per 10 sea skaters per one day). After the transfer to one of 6 salinity conditions, whether the specimen were living and also whether they were in the legs-paralysis due to low salinity were checked every 1 hours without no food during being kept.

(4) Results and Discusssion

Population density and other Meteorological factors

The samplings of *Halobates* (Table 1) inhabiting two locations at 01ºS55’S, 083º24’E (Station 1) and 08º00’S, 080º30’E (Stations 2-17) in subtropical Indian Ocean showed that two species of *Halobates micans* and *H.germanus* inhabited in the tropical Indian Ocean,, although *H. micans* was dominant species. This result coincides with results of the past study (Andersen & Cheng, 2004; Harada et al., 2011b). Table 2 shows a comparison of population density of *Halobates* species among three tropical sampling ranges in Indian and Pacific Oceans. At the fixed location of 08º00’S, 080º30’E, one third of the density of *H. micans* can be estimated , compared with the density in relatively wide area of 8N-6S, 76-86E in the Indian Ocean. Probably the low activity of photosynthesis and relatively high oxygen consumption which can be suggested by low amount of chlorophyll in surface sea water in this fixed location may be related to relatively low density of *Halobates*, because low photosynthesis activity and high dissolved oxygen show extremely low amount of animals like as zooplankton and nekton which mean low amount of foods for sea skaters (Fig. 1).

Samplings at the fixed location at 08º00’S, 080º30’E showed that higher population density (20491.4 individuals/km^2) of *Halobates micans* was estimated at the stations where air temperature was 27.5ºC than that (12070.9 individuals/km^2) in the stations at which air temp. was less than 27.5 ºC (Mann-Whitney U-test: z=-2.614, p=0.009)(Fig. 2). Similar result in the population density of larvae (481 larvae of *H. micans* and 70 ones of *H. germanus* were collected in total at Stations 1-17: Table 3) implies higher reproductive activity when the air temperature become higher than 27.5 ºC (z=-2.935, p=0.003)(Fig. 3).

Laboratory experiment

Heat semi-coma temperature (HSCT), heat coma temperature (HCT), gap temperature for heat coma (GTHC) super cooling point (SCP) and Increased temperature at super cooling point (ITSCP) were ranged 29 ºC to 41 ºC, 30 ºC to 41ºC, 1ºC to 13ºC, -21.4ºC to -9.1ºC and 0.5ºC to 11.7Cº, respectively (Table 4).

No significant correlation between HCT (or GTHC) and SCP was shown at all in *H. micans* and also *H. germanus* (Pearson’s correlation test: r=-0.031, p=0.901, n=19) (Fig. 4), whereas Harada et al (2010) showed that clear negative correlation was shown not by female-adults but by male-adults of *H. sericeus* in the area of 34˚43’N, 140˚14’E to 19˚33’N, 164˚44’W in the temperate and subtropical Pacific Ocean. On the other hand, in the area of 00˚04’N-09˚59’N, 146˚59’E-156˚20’E of the central tropical Pacific Ocean, adults of *H. sericeus* showed very clear and significant negative correlation (Pearson’s correlation test: r=-0.463, p=0.011, n=26) (Harada *et al.*, 2009). Such negative correlation between heat resistance and SCP might imply a

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physiological cross tolerance between heat and cold hardiness, because SCP could be one index of cold hardiness. In the open ocean, only *H. sericeus* showed relatively clear correlation. This phenomenon may link to that only this species is "rider" on the several currents, especially "*Kuroshio*" current (Harada, submitted). Parallel physiological development of both cold and heat hardiness could be hypothesized to be evolved only this "rider sea skaters". However, many actual data to support this hypothesis are remained to be got currently.

Exceptionally high heat tolerance was shown in this area of 08º00'S, 80º30'S in the tropical Indian Ocean. Average of THP was abound 40Cº and 39Cº for *H. germanus* and *H. micans* (Tables 5-A,B,C). This high value by both species is much higher than that in any other subtropical and tropical open ocean area in Indian and Pacific Ocean (Harada *et al.*, 2008; Harada *et al.*, 2011b) by 3-5ºC. Such high heat resistance coincides with high heat coma temperature of 39Cº as average value at 06º25'S, 089º00'E in the tropical Indian Ocean (Harada *et al.*, 2011b). Harada *et al.* (2011b) discuss on such extreme high heat resistance that currents get together from North and South in this area and some special temperature dynamics appearing here can be related to the extreme high temperature hardiness. The chief scientist of this cruise and a Meteorologist, Dr Kunio Yoneyama kindly gave us a very important comment that this fixed position of 08º00'S, 080º00'E is included in the special area of 5-10ºS, 75º-95ºE where intra-seasonal temperature variation is highest in the world open oceans. This high resistance to high temperature shown by *H. micans* might be naturally selected within one generation which is proposed within 2-3 months or also over generations by such dynamic air and water temperatures around sea surface. However, the relationship between heat tolerance of sea skaters and meteorological data are currently remained to be analyzed for the near future.

After the application to the Heat Coma Experiment (HC exp.), super-cooling points shown by adults became significantly higher by 2ºC than those by specimen without the application (Table 6). Heat stimulation during the HC exp. might increase the osmotic pressure of heamolymph up to the level of -16ºC of SCP as one speculation.

The relationship between heat hardiness and SCP, and several physical parameters (current speed, air temp., dissolved oxygen and chlorophyll from CTD data) in each day when sampling was performed should be also analyzed.

Salinity experiment

Most of the specimen at 10‰ and 9‰ and all specimen at 8-0‰ were under the paralysis of all six legs due to lower salinity concentration. However, the longer the time needed for the paralysis to be dead , the higher the salinity concentration. Due to similar experiments performed during the cruises of KH-09-07 and KH-10-05, similar survival duration among 36-12‰ were shown in *Halobates sp.* and *Halobates micans.* Therefore, no sharp-critical response but instead gradual responses to salinity were shown between 10-0‰ for the survival days under starvation. Another threshold salinity concentration for triggering the paralysis due to lower salinity so called "low salinity shock" seems to be located between 12‰ and 10‰.

(5) Additional Analyses

The data on field samplings in this study and environmental data on the oceanography during the cruise should be compared to the sampling data and related oceanography data in the area of 34˚43'N - 19˚39'N, 140˚14'E - 163˚48' W, in the Pacific Ocean at the cruise, KH-10-04-Leg 1, as well as those in the area of 4S to 13S and 8 º N to 6 º S in the Indian Ocean at two cruises, KH-10-05-Leg 1(Harada et al., 2010) and KH-07-04-Leg1 (Harada *et al*., 2008), respectively and those in the area of 30-35 º N along the Kuroshio Current at the cruises, KT-07-19, KT-08-23, KT-09-20 and the other R/V TANSEIMARU cruises held in the past.

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Cross tolerance between heat and cold hardiness was shown by *Halobates* inhabiting western tropical Pacific Ocean with 0-8N, 147-156E during the MR-09-04 and also shown by male *Halobates sericeus* in the cruise of KH-10-04-Leg 1. SCP measurement and heat paralysis experiment were done in the same manner during the cruise KT-09-20 in September, 2009. The relationship of the extent of the heat tolerance and SCP value should be analyzed to the ocean dynamics like as surface air and water temperature, dissolved oxygen and chlorophyll contents in the Pacific and Indian Ocean in the near future.

The video camera data will be also analyzed after the cruise to examine the frequency and speed of skating and their responses to the temperature differences. Dissection data (for example reproductive maturation), chemical contents data (example lipids) and gene data of MtDNA from *Halobates* samples should be analyzed in the future.

For the salinity experiments, raw data were shown in this report and all the statistical analyses should be done as soon as possible after the cruise.

(6) Data Archive

All data during this cruise will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG).

(7) Acknowledgements

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Table 1-A. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity(‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		
01°55'S	083°24E	7	0	1	6	4	3	0	0	0	St.1-1	29.0	27.9	5.2	Fine	0.9	130°	18:24~39	Sep 27	804.0	189.34	0.955	32
01°56'S	083°24'E	14	3	6	5	9	5	0	0	0	St.1-2	29.0	27.9	4.3	Fine	0.9	97°	18:43-58	Sep 27	767.0	189.34	0.955	32
01°55'S	083°24'E	9	3	2	4	5	4	0	0	0	St.1-3	29.0	27.9	4.8	Fine	1.0	119°	19:03-18	Sep 27	801.0	189.34	0.955	32
08°00'S	080°30'E	4	2	1	1	2	2	0	0	0	St.2-1	28.4	26.7	5.0	Cloud	0.4	311°	20:34~49	Sep 30	615.0	189.04	1.190	32
08°00'S	080°30'E	0	0	0	0	0	0	0	0	2	St.2-2	28.4	26.7	4.4	Cloud	0.3	266°	20:53~21:08	Sep 30	503.0	189.04	1.190	32
08°00'S	080°30'E	3	3	0	0	1	2	0	0	0	St.2-3	28.4	26.7	4.4	Cloud	0.3	273°	21:13~28	Sep 30	570.0	189.04	1.190	32
08°00'S	080°29'E	9	3	3	3	3	6	0	0	0	St.3-1	28.2	25.2	9.3	Rainy	0.4	265°	20:58~21:13	Oct 1	760.0	189.8	1.240	32
08°00'S	080°29'E	10	5	4	1	9	1	0	0	0	St.3-2	28.2	25.2	11.2	Rainy	0.3	269°	21:20~35	Oct 1	656.0	189.8	1.240	32
08°00'S	080°29'E	19	7	8	4	18	1	0	0	0	St.3-3	28.2	25.2	13.5	Rainy	0.4	279°	21:39~54	Oct 1	604.0	189.8	1.240	32
08°00'S	080°30'E	11	9	1	1	7	4	0	0	0	St.4-1	28.5	27.8	8.6	F/C	0.7	141°	20:56~21:11	Oct 3	656.0	189.62	0.63	31
08°00'S	080°30'E	20	15	2	3	15	5	0	0	0	St.4-2	28.5	27.8	7.8	F/C	0.7	155°	21:16~31	Oct 3	663.0	189.62	0.63	31
08°01'S	080°30'E	65	10	9	46	62	3	0	0	0	St.4-3	28.5	27.8	8.0	F/C	0.8	158°	21:35~50	Oct 3	667.0	189.62	0.63	31
08°00'S	080°29'E	21	11	7	3	19	2	0	0	0	St.5-1	28.5	25.4	4.7	Rainy	0.2	209°	20:50~21:05	Oct 4	569.0	189.45	0.84	32
08°00'S	080°30'E	22	11	8	3	20	2	0	0	1	St.5-2	28.5	25.4	8.6	Rainy	0.1	152°	21:10~25	Oct 4	504.0	189.45	0.84	32
08°00'S	080°30'E	84	68	10	6	64	20	0	0	3	St.5-3	28.5	25.4	9.5	Rainy	0.5	176°	21:29~44	Oct 4	601.0	189.45	0.84	32
07˚59'S	080˚29' E	6	4	1	1	3	3	0	0	0	St.6-1	28.4	26.7	10.4	C/R	0.9	185 °	20:54-21:09	Oct 6	662.0	189.85	0.67	32
08˚00'S	080˚29' E	11	9	1	1	7	4	0	0	0	St.6-2	28.4	26.7	9.2	C/R	0.7	189°	21:13- 28	Oct 6	690.0	189.85	0.67	32

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08˚01'S	080˚30' E	7	6	1	0	7	0	0	0	0	St.6-3	28.4	26.7	7.5	C/R	0.7	206º	21:33- 48	Oct 6	552.0	189.85	0.67	32
07˚59'S	080˚29'E	10	7	0	3	3	7	0	0	0	St.7-1	28.5	27.4	4.2	Fine	0.2	154 º	20: 49-21:04	Oct 7	787.0	189.46	0.56	32
08˚00'S	080˚30'E	9	6	1	2	4	5	0	0	0	St.7-2	28.5	27.4	4.1	Fine	0.3	121 º	21: 09-24	Oct 7	594.0	189.46	0.56	32
08˚00'S	080˚30'E	6	4	1	1	3	3	0	0	0	St.7-3	28.5	27.4	4.4	Fine	0.4	129º	21:29-44	Oct 7	621.0	189.46	0.56	32
07˚59'S	080˚29'E	15	12	1	2	12	3	0	0	0	St.8-1	28.5	26.8	6.5	Fine	0.4	230º	20:49~21:04	Oct 9	766.0	189.92	1.23	32
08˚00'S	080˚29'E	11	8	0	3	9	2	0	0	1	St.8-2	28.5	26.8	6.2	Fine	0.5	221º	21:09~24	Oct 9	684.0	189.92	1.23	32
08˚00'S	080˚29'E	9	7	1	1	6	3	0	0	2	St.8-3	28.5	26.8	8.2	Fine	0.5	208º	21:29~44	Oct 9	582.0	189.92	1.23	32
07˚59'S	080˚29'E	3	2	0	1	3	0	0	0	0	St.9-1	28.3	27.3	12.7	Cloudy	1.0	179º	20:51~21:06	Oct10	708.0	192.10	2.08	32
08˚00'S	080˚29'E	14	8	2	4	14	0	0	0	1	St.9-2	28.3	27.3	12.0	Cloudy	0.5	206º	21:11~26	Oct 10	698.0	192.10	2.08	32
08˚01'S	080˚29'E	7	5	1	1	6	1	0	0	0	St.9-3	28.3	27.3	12.5	Cloudy	0.5	196º	21:30~45	Oct 10	595.0	192.10	2.08	32

Table 1-B. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		
07˚59'S	080˚29'E	23	17	5	1	23	0	0	0	2	St.10-1	28.2	27.7	11.6	Fine	0.8	231º	20:55~21:10	Oct 12	688.0	189.12	1.08	32
08˚00'S	080˚29'E	16	12	3	1	12	4	0	0	3	St.10-2	28.2	27.7	10.8	Fine	0.4	193º	21:15~30	Oct 12	622.0	189.12	1.08	32
08˚00'S	080˚29'E	32	20	6	6	32	0	0	0	0	St.10-3	28.2	27.7	11.4	Fine	0.4	191º	21:35~50	Oct 12	602.0	189.12	1.08	32
08˚00'S	080˚29'E	15	9	5	1	13	2	0	0	0	St.11-1	28.2	27.5	9.6	Fine	0.4	197º	20:53~21:08	Oct 13	612.0	189.03	0.695	32
08˚00'S	080˚29'E	10	7	1	2	10	0	0	0	0	St.11-2	28.2	27.5	9.5	Fine	0.5	219º	21:14-29	Oct 13	592.0	189.03	0.695	32
08˚00'S	080˚30'E	13	13	0	0	12	1	0	0	2	St.11-3	28.2	27.5	10.9	Fine	0.3	204º	21:34-49	Oct 13	554.0	189.03	0.695	32
07˚59'S	080˚29'E	19	15	1	3	19	0	0	0	0	St.12-1	28.4	27.9	9.1	Fine	0.8	184º	20:51~21:0 6	Oct 15	593.0	188.75	0.405	32

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08˚00'S	080˚29'E	13	10	1	2	13	0	0	0	0	St. 12-2	28.4	27.9	8.6	Fine	0.8	185º	21:10~25	Oct 15	658.0	188.75	0.405	32
08˚01'S	080˚30'E	14	12	2	0	14	0	0	0	2	St. 12-3	28.4	27.9	10.0	Fine	0.8	183º	21:30~45	Oct 15	698.0	188.75	0.405	32
07˚59'S	080˚29'E	12	10	1	1	12	0	0	0	0	St.13-1	28.4	27.9	13.0	Fine	0.3	214º	20:55~21:10	Oct 16	623.0	188.58	0.475	32
08˚00'S	080˚29'E	20	16	1	3	19	1	0	0	1	St.13-2	28.4	27.9	11.8	Fine	0.2	190º	21:15~30	Oct 16	625.0	188.58	0.475	32
08˚00'S	080˚30'E	23	19	1	3	21	2	0	0	0	St.13-3	28.4	27.9	11.5	Fine	0.4	193º	21:35~50	Oct 16	654.0	188.58	0.475	32
07º59'S	080º29'E	5	4	0	1	5	0	0	0	0	St.14-1	28.4	27.6	9.8	Fine	0.5	244º	20:54~21:09	Oct 18	641.0	187.86	0.575	32
07º59'S	080º29'E	22	16	4	2	22	0	0	0	1	St.14-2	28.4	27.6	9.6	Fine	0.5	224º	21:14~29	Oct 18	688.0	187.86	0.575	32
08º00'S	080º30'E	8	7	1	0	8	0	0	0	0	St.14-3	28.4	27.6	11.2	Fine	0.5	246º	21:33~48	Oct 18	645.0	187.86	0.575	32
07º59'S	080º30'E	11	10	1	0	11	0	0	0	0	St.15-1	28.3	27.7	5.9	Fine	0.2	213º	20:55~21:10	Oct 19	663.0	187.91	0.43	32
07º59'S	080º30'E	18	16	1	1	17	1	0	0	0	St.15-2	28.3	27.7	7.7	Fine	0.4	254º	21:15~30	Oct 19	678.0	187.91	0.43	32
08º00'S	080º30'E	22	18	3	1	22	0	0	0	0	St.15-3	28.3	27.7	5.8	Fine	0.3	249º	21:35~50	Oct 19	632.0	187.91	0.43	32
07˚59'S	080˚30' E	18	16	2	0	18	0	0	0	2	St.16-1	28.6	27.9	4.9	Fine	0.7	259 º	21:00-15	Oct 21	790.0	188.72	0.28	32
07˚59'S	080˚29' E	17	16	1	0	17	0	0	0	1	St.16-2	28.6	27.9	5.8	Fine	0.5	274º	21:20- 35	Oct 21	823.0	188.72	0.28	32
08˚00'S	080˚29' E	38	34	3	1	34	4	0	0	3	St.16-3	28.6	27.9	4.4	Fine	0.8	250º	21:40- 55	Oct 21	850.0	188.72	0.28	32
07˚59'S	080˚29'E	7	5	0	2	6	1	0	0	0	St.17-1	28.8	27.7	5.5	Fine	0.4	230º	20:53~21:08	Oct 22	834.0	186.22	0.22	32
08˚00'S	080˚29'E	13	11	2	0	12	1	0	0	1	St.17-2	28.8	27.7	3.9	Fine	0.6	233º	21:13~28	Oct 22	664.0	186.22	0.22	32
08˚00'S	080˚30'E	11	10	0	1	10	1	0	0	2	St.17-3	28.8	27.7	5.1	Fine	0.3	249º	21:33~48	Oct 22	631.0	186.22	0.22	32

Table 1-C. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		

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08˚00'S 080˚29'E	**5**	**4**	**1**	**0**	**5**	**0**	**0**	**0**	**1**	**St.18-1**	**28.4**	**27.9**	**5.6**	**Fine**	**0.6**	**109º**	**20:55~21:10**	**Oct 31**	**831.0**	**186.78**	**0.43**	**32**
08˚00'S 080˚30'E	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**St.18-2**	**28.4**	**27.9**	**6.4**	**Fine**	**0.8**	**108º**	**21:15~30**	**Oct 31**	**762.0**	**186.78**	**0.43**	**32**
08˚00'S 080˚31'E	**3**	**1**	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**St.18-3**	**28.4**	**27.9**	**5.4**	**Fine**	**0.6**	**109º**	**21:35~50**	**Oct 31**	**809.0**	**186.78**	**0.43**	**32**
08˚01'S 080˚30'E	**7**	**7**	**0**	**0**	**6**	**1**	**0**	**0**	**0**	**St.19-1**	**28.4**	**27.9**	**6.2**	**Fine**	**0.3**	**141º**	**20:52~21:07**	**Nov 1**	**766.0**	**186.98**	**0.45**	**32**
08˚00'S 080˚30'E	**9**	**7**	**2**	**0**	**9**	**0**	**0**	**0**	**1**	**St.19-2**	**28.4**	**27.9**	**8.1**	**Fine**	**0.5**	**145º**	**21:15-30**	**Nov 1**	**792.0**	**186.98**	**0.45**	**32**
08˚01'S 080˚30'E	**13**	**7**	**3**	**3**	**11**	**2**	**0**	**0**	**1**	**St.19-3**	**28.4**	**27.9**	**7.3**	**Fine**	**1.2**	**144º**	**21:35-50**	**Nov 1**	**802.0**	**186.98**	**0.45**	**32**
08˚00'S 080˚30'E	**19**	**15**	**1**	**3**	**19**	**0**	**0**	**0**	**2**	**St.20-1**	**28.5**	**27.5**	**7.7**	**F/R**	**0.3**	**101º**	**20:58~21:13**	**Nov 2**	**796.0**	**187.30**	**0.46**	**32**
08˚00'S 080˚30'E	**10**	**3**	**4**	**3**	**10**	**0**	**0**	**0**	**1**	**St. 20-2**	**28.5**	**27.5**	**8.0**	**F/R**	**0.4**	**114º**	**21:18~33**	**Nov 2**	**767.0**	**187.30**	**0.46**	**32**
08˚00'S 080˚31'E	**13**	**10**	**2**	**1**	**12**	**1**	**0**	**0**	**0**	**St. 20-3**	**28.5**	**27.5**	**11.0**	**F/R**	**0.9**	**120º**	**21:38~53**	**Nov 2**	**754.0**	**187.30**	**0.46**	**32**
08˚00'S 080˚30'E	**3**	**2**	**0**	**1**	**3**	**0**	**0**	**0**	**1**	**St.21-1**	**28.4**	**27.8**	**6.6**	**Fine**	**0.1**	**191º**	**20:57~21:12**	**Nov 3**	**758.0**	**187.83**	**0.41**	**31**
08˚00'S 080˚30'E	**6**	**2**	**3**	**1**	**6**	**0**	**0**	**0**	**0**	**St.21-2**	**28.4**	**27.8**	**6.4**	**Fine**	**0.4**	**202º**	**21:16~31**	**Nov 3**	**650.0**	**187.83**	**0.41**	**31**
08˚00'S 080˚31'E	**7**	**5**	**2**	**0**	**7**	**0**	**0**	**0**	**0**	**St.21-3**	**28.4**	**27.8**	**6.6**	**Fine**	**0.9**	**194º**	**21:36~51**	**Nov 3**	**585.0**	**187.83**	**0.41**	**31**
08º00'S 080º30'E	**5**	**5**	**0**	**0**	**5**	**0**	**0**	**0**	**2**	**St.22-1**	**28.4**	**27.7**	**4.2**	**Fine**	**0.3**	**179º**	**20:56~21:11**	**Nov 4**	**745.0**	**188.00**	**0.44**	**32**
08º00'S 080º30'E	**3**	**1**	**0**	**2**	**3**	**0**	**0**	**0**	**0**	**St.22-2**	**28.4**	**27.7**	**7.3**	**Fine**	**0.4**	**167º**	**21:16~31**	**Nov 4**	**788.0**	**188.00**	**0.44**	**32**
08º00'S 080º31'E	**4**	**4**	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**St.22-3**	**28.4**	**27.7**	**9.2**	**Fine**	**0.3**	**161º**	**21:35~50**	**Nov 4**	**604.0**	**188.00**	**0.44**	**32**
08º00'S 080º30'E	**12**	**8**	**2**	**2**	**12**	**0**	**0**	**0**	**1**	**St.23-1**	**28.4**	**27.6**	**8.2**	**F/R**	**0.1**	**230º**	**20:53~21:08**	**Nov 5**	**741.0**	**188.10**	**0.38**	**32**
07º59'S 080º30'E	**6**	**3**	**1**	**2**	**6**	**0**	**0**	**0**	**0**	**St.23-2**	**28.4**	**27.6**	**7.4**	**F/R**	**0.3**	**197º**	**21:15~30**	**Nov 5**	**655.0**	**188.10**	**0.38**	**32**
08º00'S 080º30'E	**11**	**9**	**1**	**1**	**10**	**1**	**0**	**0**	**1**	**St.23-3**	**28.4**	**27.6**	**9.5**	**F/R**	**0.2**	**137º**	**21:35~50**	**Nov 5**	**754.0**	**188.10**	**0.38**	**32**
08˚00'S 080˚29' E	**9**	**8**	**0**	**1**	**9**	**0**	**0**	**0**	**0**	**St.24-1**	**28.4**	**27.6**	**5.7**	**Fine**	**0.7**	**259 º**	**20:54-21:09**	**Nov 6**	**779.0**	**188.00**	**0.33**	**32**
08˚00'S 080˚30' E	**8**	**7**	**1**	**0**	**8**	**0**	**0**	**0**	**0**	**St.24-2**	**28.4**	**27.6**	**7.5**	**Fine**	**0.5**	**274º**	**21:14- 29**	**Nov 6**	**774.0**	**188.00**	**0.33**	**32**
08˚00'S 080˚31' E	**6**	**3**	**2**	**1**	**6**	**0**	**0**	**0**	**0**	**St.24-3**	**28.4**	**27.6**	**7.9**	**Fine**	**0.8**	**250º**	**21:34- 49**	**Nov 6**	**784.0**	**188.00**	**0.33**	**32**
08˚00'S 080˚30'E	**7**	**4**	**1**	**2**	**7**	**0**	**0**	**0**	**0**	**St.25-1**	**28.4**	**27.9**	**9.6**	**Fine**	**0.4**	**265º**	**20:52~21:07**	**Nov 8**	**704.0**	**187.82**	**0.33**	**31**
08˚00'S 080˚29'E	**12**	**10**	**1**	**1**	**12**	**0**	**0**	**0**	**0**	**St.25-2**	**28.4**	**27.9**	**8.3**	**Fine**	**0.2**	**217º**	**21:11~26**	**Nov 8**	**904.0**	**187.82**	**0.33**	**31**
08˚00'S 080˚30'E	**6**	**2**	**3**	**1**	**6**	**0**	**0**	**0**	**0**	**St.25-3**	**28.4**	**27.9**	**9.8**	**Fine**	**0.4**	**211º**	**21:31~46**	**Nov 8**	**801.0**	**187.82**	**0.33**	**31**

Table 1-D. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates*

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micans; H.g.: Halobates germanus; H.s.: Halobates sericeus; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	Longitude	N	L	A		*H.m.*	*H.g.*	*H.s.*	EG	E	Stat	WT	AT	WS	W	CS	CD	TD	Date	S(x1.3 m^2)	DO	Chl	SL
				F	M																		
08˚00'S	080˚30'E	26	18	4	4	26	0	0	0	0	St.26-1	28.4	27.4	4.2	Fine	0.6	262º	20:53~21:08	Nov 9	864.0	188.2	0.27	32
08˚00'S	080˚30'E	29	24	2	3	29	0	0	0	1	St.26-2	28.4	27.4	4.7	Fine	0.6	288º	21:13~28	Nov 9	723.0	188.2	0.27	32
08˚01'S	080˚30'E	32	32	0	0	32	0	0	0	1	St.26-3	28.4	27.4	5.2	Fine	0.5	284º	21:32~47	Nov 9	663.0	188.2	0.42	32
08˚00'S	080˚30'E	9	7	2	0	8	1	0	0	1	St.27-1	28.2	27.7	6.8	Fine	0.3	269º	20:56~21:11	Nov 11	748.0	188.74	0.35	32
08˚00'S	080˚30'E	28	28	0	0	27	1	0	0	0	St.27-2	28.2	27.7	5.3	Fine	0.5	286º	21:15-30	Nov 11	782.0	188.74	0.35	32
08˚00'S	080˚31'E	43	38	4	1	40	3	0	0	1	St.27-3	28.2	27.7	5.9	Fine	1.2	295º	21:35-50	Nov 11	794.0	188.74	0.35	32
08˚00'S	080˚30'E	19	15	1	3	19	0	0	0	2	St.28-1	28.5	27.5	2.7	Fine	0.4	296º	20:53~21:08	Nov 12	804.0	189.28	0.28	32
08˚00'S	080˚29'E	10	3	4	3	10	0	0	0	1	St. 28-2	28.5	27.5	1.2	Fine	0.4	296º	21:13~28	Nov 12	664.0	189.28	0.28	32
08˚01'S	080˚29'E	13	10	2	1	12	1	0	0	0	St. 28-3	28.5	27.5	1.3	Fine	0.4	298º	21:33~48	Nov 12	591.0	189.28	0.28	32
08˚00'S	080˚30'E	6	4	2	0	6	0	0	0	1	St.29-1	28.1	27.5	7.5	Fine	0.7	266º	20:52~21:07	Nov 14	693.0	189.17	0.37	31
08˚00'S	080˚30'E	10	7	1	2	10	0	0	0	1	St.29-2	28.1	27.5	8.0	Fine	0.8	276º	21:12~27	Nov 14	615.0	189.17	0.37	31
08˚00'S	080˚30'E	12	9	2	1	11	1	0	0	2	St.29-3	28.1	27.5	7.9	Fine	0.7	264º	21:31~46	Nov 14	641.0	189.17	0.37	31
08º00'S	080º30'E	13	7	3	3	13	0	0	0	1	St.30-1	28.2	27.6	8.8	F/R	0.7	274º	20:53~21:08	Nov 15	921.0	189.24	0.29	31
08º00'S	080º30'E	19	12	4	3	19	0	0	0	0	St.30-2	28.2	27.6	9.4	F/R	0.5	267º	21:13~28	Nov 15	868.0	189.24	0.29	31
08º00'S	080º31'E	28	21	4	3	28	0	0	0	0	St.30-3	28.2	27.6	8.9	Fine	0.6	242º	21:32~47	Nov 15	905.0	189.24	0.29	31
08º00'S	080º30'E	10	7	0	3	10	0	0	0	0	St.31-1	28.3	27.5	6.5	Fine	0.6	262º	20:50~21:05	Nov 17	746.0	188.85	0.36	31
08º00'S	080º30'E	10	7	1	2	10	0	0	0	1	St.31-2	28.3	27.5	7.5	Fine	0.3	290º	21:10~25	Nov 17	582.0	188.85	0.36	31
08º00'S	080º31'E	10	4	2	4	10	0	0	0	0	St.31-3	28.4	27.5	7.9	Fine	0.5	299º	21:29~44	Nov 17	755.0	188.85	0.36	31
08˚00'S	080˚29' E	9	8	0	1	9	0	0	0	1	St.32-1	28.4	28.0	9.3	F/R	0.8	268 º	20:54-21:09	Nov 18	985.0	188.67	0.30	32

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08˚00'S	**080˚29' E**	**17**	**10**	**3**	**4**	**16**	**1**	**0**	**0**	**0**	**St.32-2**	**28.4**	**28.0**	**10.2**	**F/R**	**0.9**	**262º**	**21:14- 29**	**Nov 18**	**1030.0**	**188.67**	**0.30**	**32**
08˚01'S	**080˚29' E**	**9**	**3**	**3**	**3**	**9**	**0**	**0**	**0**	**0**	**St.32-3**	**28.4**	**28.0**	**9.3**	**F/R**	**0.9**	**269º**	**21:45-22:00**	**Nov 18**	**665.0**	**188.67**	**0.30**	**32**
08˚00'S	**080˚30'E**	**15**	**9**	**3**	**3**	**15**	**0**	**0**	**0**	**1**	**St.33-1**	**28.4**	**27.7**	**7.1**	**Fine**	**0.4**	**265º**	**20:54~21:09**	**Nov 20**	**720.0**	**188.71**	**0.27**	**32**
08˚00'S	**080˚30'E**	**24**	**12**	**5**	**7**	**23**	**1**	**0**	**0**	**0**	**St.33-2**	**28.4**	**27.7**	**6.9**	**Fine**	**0.5**	**262º**	**21:14~29**	**Nov 20**	**788.0**	**188.71**	**0.27**	**32**
08˚01'S	**080˚31'E**	**23**	**11**	**5**	**7**	**23**	**0**	**0**	**0**	**1**	**St.33-3**	**28.4**	**27.7**	**7.5**	**Fine**	**0.4**	**271º**	**21:33~48**	**Nov 20**	**833.0**	**188.71**	**0.27**	**32**

Table 1-E. Number of *Halobates* collected at locations in the tropical Indian Ocean in Sep. 27, 2011 (N:Total number of individuals collected; *H.m.: Halobates micans; H.g.: Halobates germanus; H.s.: Halobates sericeus*; Stat: Station number; WT: Water temperature (℃); AT: Air temp.; L: N of larvae; A: N of adults, E: N of exuviae; Date: sampling date; Sampling was performed for 45min. EG: eggs on some substrates like as polystyrene form thousands of eggs laid on the substrate. S: Surface area which was swept by Neuston NET was expressed as value of flow-meter x 1.3m of width of Neuston NET; WS: wind speed (m/s); W: weather; TD: Time of day; WS: Wind speed, CS: Current speed(m/s)CD: Current direction; F: female; M: male; DO: dissolved oxygen (μmol/kg); Chl: Chlorophyll-A conc.(relative fluorescent value); SL: salinity (‰)

Latitude	**Longitude**	**N**	**L**	**A**		***H.m.***	***H.g.***	***H.s.***	**EG**	**E**	**Stat**	**WT**	**AT**	**WS**	**W**	**CS**	**CD**	**TD**	**Date**	**S(x1.3 m²)**	**DO**	**Chl**	**SL**
				F	**M**																		
08˚00'S	**080˚29'E**	**6**	**5**	**1**	**0**	**6**	**0**	**0**	**0**	**0**	**St.34-1**	**28.2**	**27.5**	**4.5**	**Fine**	**0.8**	**292º**	**20:52~21:07**	**Nov 21**	**864.0**	**189.4**	**0.33**	**31**
08˚00'S	**080˚30'E**	**3**	**3**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**St.34-2**	**28.2**	**27.5**	**5.4**	**Fine**	**0.7**	**301º**	**21:12~27**	**Nov 21**	**723.0**	**189.4**	**0.33**	**31**
08˚00'S	**080˚30'E**	**5**	**4**	**1**	**0**	**4**	**1**	**0**	**0**	**1**	**St.34-3**	**28.2**	**27.5**	**5.3**	**Fine**	**0.7**	**268º**	**21:31~46**	**Nov 21**	**584.0**	**189.4**	**0.33**	**31**
08˚00'S	**080˚30'E**	**10**	**7**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**St.35-1**	**28.4**	**27.5**	**5.8**	**Fine**	**0.6**	**254º**	**20:51~21:07**	**Nov 23**	**848.0**	**189.42**	**0.40**	**32**
08˚00'S	**080˚30'E**	**8**	**6**	**2**	**0**	**0**	**0**	**0**	**0**	**1**	**St.35-2**	**28.4**	**27.5**	**5.5**	**Fine**	**0.5**	**263º**	**21:10-25**	**Nov 23**	**688.0**	**189.42**	**0.40**	**32**
08˚01'S	**080˚30'E**	**5**	**4**	**1**	**0**	**5**	**0**	**0**	**0**	**0**	**St.35-3**	**28.4**	**27.5**	**6.0**	**Fine**	**0.6**	**256º**	**21:29-44**	**Nov 23**	**708.0**	**189.42**	**0.40**	**32**
08˚00'S	**080˚30'E**	**16**	**9**	**5**	**2**	**16**	**0**	**0**	**0**	**1**	**St.36-1**	**28.2**	**27.9**	**6.2**	**Fine**	**0.7**	**296º**	**20:52~21:07**	**Nov 24**	**763.0**	**189.28**	**0.48**	**32**
08˚00'S	**080˚29'E**	**13**	**5**	**3**	**5**	**13**	**0**	**0**	**0**	**0**	**St. 36-2**	**28.2**	**27.9**	**7.0**	**Fine**	**0.9**	**296º**	**21:11~26**	**Nov 24**	**583.0**	**189.28**	**0.48**	**32**
08˚01'S	**080˚29'E**	**14**	**4**	**6**	**4**	**14**	**0**	**0**	**0**	**0**	**St. 36-3**	**28.2**	**27.9**	**7.7**	**Fine**	**0.6**	**298º**	**21:31~46**	**Nov 24**	**562.0**	**189.28**	**0.48**	**32**

Table 2: A comparison of population density of oceanic sea skaters, Halobates among three area of open Indian

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and Pacific Oceans. Samplings were performed the three cruises including this cruise. *H.m: Halobates micans; H.g.: H. germanus; H.s.: H. sericeus; H.p.: H. princeps;* sp.: *H.* sp.: Density: individual number/km^2

1. MR-10-03: Western Tropical Pacific Ocean, 5ºN, 139º30’E (Harada et al., 2010)

	Total		*H.m*	*H.g*	*H. s .*	*H. p or* sp	AS#
	Nymphs	Adults					
Number	3772	383	4059	66	1	28	0.105310
Density	35834.0	3638.5	38560.5	627.0	9.5	266.0	-

2.KH-07-04-Leg 1: Eastern Tropical Indian Ocean, 8ºN-6º35’S, 86ºE- 76º36’E) (Harada et al., 2010)

	Total		*H.m*	*H.g*	*H. s .*	*H. p or* sp	AS#
	Nymphs	Adults					
Number	1291	706	1886	111	0	0	0.044292
Density	29147.5	15939.7	42581.1	2506.1	0	0	-

3. MR-11-07-Leg 1 (this cruise, Stations 1-17): Eastern Tropical Indian Ocean, 01º55’S, 083º24E 8ºS, 80º30’E)

	Total		*H.m*	*H.g*	*H. s .*	*H. p or* sp	AS#
	Nymphs	Adults					
Number	551	255	697	109	0	0	0.0438607
Density	12562.5	5813.9	15891.2	2485.1	0	0	-

Table 3-A. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at 01º55’S, 083º24E (St 1) and around 80º00’S, 080º30’E(St 2 to St 10) in the tropical Indian Ocean.

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	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**
St1-1	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**3**
St1-2	**0**	**0**	**0**	**0**	**1**	**4**	**4**	**0**	**0**	**1**	**0**	**1**	**2**	**1**
St1-3	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**0**	**1**	**2**	**0**	**1**	**0**
St2-1	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**
St2-2	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St2-3	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**
St3-1	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**3**
St3-2	**0**	**1**	**2**	**1**	**1**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
St3-3	**0**	**0**	**2**	**2**	**3**	**8**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
St4-1	**0**	**2**	**4**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**
St4-2	**0**	**4**	**2**	**4**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**4**	**0**	**1**
St4-3	**0**	**0**	**1**	**2**	**4**	**9**	**46**	**0**	**0**	**0**	**1**	**2**	**0**	**0**
St5-1	**2**	**1**	**1**	**1**	**5**	**6**	**3**	**1**	**0**	**0**	**0**	**0**	**1**	**0**
St5-2	**0**	**1**	**2**	**0**	**6**	**8**	**3**	**1**	**0**	**0**	**1**	**0**	**0**	**0**
St5-3	**7**	**11**	**20**	**6**	**6**	**10**	**4**	**2**	**5**	**3**	**4**	**4**	**0**	**2**
St6-1	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**
St6-2	**1**	**1**	**1**	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**2**	**1**	**0**
St6-3	**1**	**1**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St7-1	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**0**	**3**
St7-2	**0**	**0**	**1**	**0**	**2**	**0**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**1**
St7-3	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**0**
St8-1	**0**	**2**	**3**	**4**	**0**	**1**	**2**	**0**	**1**	**0**	**0**	**2**	**0**	**0**
St8-2	**2**	**1**	**1**	**2**	**0**	**0**	**3**	**0**	**1**	**0**	**0**	**1**	**0**	**0**

St8-3	**1**	**1**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**
St9-1	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St9-2	**1**	**2**	**1**	**1**	**3**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St9-3	**0**	**0**	**0**	**0**	**4**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
St10-1	**2**	**3**	**6**	**2**	**4**	**5**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St10-2	**0**	**2**	**2**	**1**	**4**	**2**	**1**	**0**	**0**	**1**	**0**	**2**	**1**	**0**
St10-3	**2**	**3**	**0**	**9**	**6**	**6**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 3-B. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at around 08º00'S,080º30'E in the tropical Indian Ocean.

	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**
St.11-1	**2**	**2**	**3**	**1**	**1**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
St.11-2	**0**	**1**	**3**	**3**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.11-3	**1**	**4**	**3**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
St.12-1	**2**	**1**	**2**	**8**	**2**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.12-2	**0**	**1**	**3**	**3**	**3**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.12-3	**2**	**2**	**3**	**1**	**4**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.13-1	**0**	**1**	**0**	**2**	**7**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.13-2	**0**	**2**	**1**	**4**	**8**	**1**	**3**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
St.13-3	**0**	**3**	**3**	**5**	**6**	**1**	**3**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
St.14-1	**0**	**1**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.14-2	**0**	**4**	**4**	**6**	**2**	**4**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.14-3	**1**	**2**	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.15-1	**2**	**2**	**3**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

St.15-2	**2**	**9**	**4**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
St.15-3	**0**	**3**	**9**	**3**	**3**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.16-1	**0**	**5**	**3**	**4**	**4**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.16-2	**1**	**2**	**4**	**5**	**4**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.16-3	**4**	**10**	**10**	**6**	**2**	**2**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**1**
St.17-1	**0**	**1**	**0**	**1**	**2**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
St.17-2	**0**	**2**	**4**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
St.17-3	**1**	**2**	**3**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
St.18-1	**1**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.18-2	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.18-3	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.19-1	**0**	**1**	**1**	**3**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
St.19-2	**1**	**2**	**2**	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.19-3	**0**	**1**	**3**	**1**	**0**	**3**	**3**	**0**	**1**	**1**	**0**	**0**	**0**	**0**
St.20-1	**0**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.20-2	**0**	**1**	**1**	**1**	**0**	**4**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.20-3	**1**	**3**	**4**	**1**	**0**	**2**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**

Table 3-C. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at around 08º00'S,080º30'E in the tropical Indian Ocean.

	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**
St.21-1	**0**	**2**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.21-2	**1**	**0**	**0**	**1**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.21-3	**0**	**1**	**3**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

.

St.22-1	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.22-2	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.22-3	**0**	**1**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
St.23-1	**0**	**5**	**2**	**1**	**0**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.23-2	**0**	**1**	**0**	**2**	**2**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.23-3	**1**	**2**	**3**	**0**	**2**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
St.24-1	**1**	**3**	**2**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.24-2	**1**	**0**	**3**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.24-3	**1**	**0**	**1**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.25-1	**0**	**0**	**0**	**4**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.25-2	**2**	**1**	**2**	**2**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.25-3	**0**	**0**	**1**	**1**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.26-1	**2**	**3**	**8**	**4**	**1**	**4**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.26-2	**1**	**4**	**9**	**7**	**3**	**2**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.26-3	**2**	**6**	**16**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.27-1	**0**	**2**	**5**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**
St.27-2	**0**	**1**	**15**	**10**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
St.27-3	**3**	**10**	**11**	**4**	**7**	**4**	**1**	**0**	**1**	**2**	**0**	**0**	**0**	**0**
St.28-1	**0**	**3**	**3**	**1**	**3**	**10**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.28-2	**0**	**2**	**8**	**7**	**5**	**5**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
St.28-3	**0**	**3**	**3**	**2**	**1**	**3**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
St.29-1	**1**	**3**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.29-2	**0**	**2**	**4**	**1**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.29-3	**0**	**2**	**3**	**2**	**1**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
St.30-1	**2**	**2**	**0**	**2**	**1**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.30-2	**0**	**1**	**4**	**6**	**1**	**4**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

.

St.30-3	**2**	**2**	**6**	**7**	**4**	**4**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 3-D. Components of instars of larvae and adults of oceanic sea skaters, *Halobates micans* and *H. germanus* sampled at around 08º00'S,080º30'E in the tropical Indian Ocean.

	Halobates micans							*H. germanus*						
						Adults							Adults	
	1st	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**F**	**M**
St.31-1	**0**	**0**	**2**	**1**	**4**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.31-2	**0**	**1**	**2**	**2**	**2**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.31-3	**0**	**1**	**1**	**2**	**2**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.32-1	**1**	**1**	**2**	**3**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.32-2	**0**	**1**	**3**	**2**	**3**	**3**	**4**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
St.32-3	**0**	**0**	**0**	**1**	**2**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.33-1	**1**	**1**	**3**	**3**	**1**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.33-2	**1**	**3**	**4**	**0**	**3**	**5**	**7**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
St.33-3	**0**	**1**	**5**	**3**	**2**	**5**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.34-1	**0**	**1**	**0**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.34-2	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
St.24-3	**1**	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
St.35-1	**0**	**1**	**2**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.35-2	**0**	**2**	**2**	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.35-3	**0**	**1**	**1**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.36-1	**4**	**0**	**1**	**2**	**4**	**5**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.36-2	**1**	**1**	**1**	**0**	**2**	**3**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
St.36-3	**0**	**0**	**1**	**0**	**3**	**6**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

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Table 4-Sheet 1. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis_(from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**30**	**2**	**-17.4**	**4.9**	**H.m.**	**Adult (male)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**30**	**2**	**-15.0**	**4.0**	**H.m.**	**Adult(female)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**30**	**2**	**-17.6**	**2.6**	**H.m.**	**Adult(female)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**35**	**7**	**-16.4**	**8.2**	**H.m.**	**Adult (male)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**36**	**8**	**-13.5**	**6.6**	**H.m.**	**Adult (male)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**37**	**9**	**-9.4**	**4.6**	**H.m.**	**Adult (female)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**38**	**10**	**-14.5**	**7.8**	**H.m.**	**5th instar**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**40**	**12**	**-11.7**	**7.2**	**H.m.**	**Adult (female)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**40**	**12**	**-10.7**	**7.8**	**H.g.**	**Adult (female)**	**Sep 28**	**07:00~**
St. 1	**01°56'S**	**083°24'E**	**1**	**28**	**-**	**41**	**13**	**-15.1**	**5.6**	**H.g.**	**Adult (female)**	**Sep 28**	**07:00~**
St.2	**08°00'S**	**080°30'E**	**2**	**28**	**35**	**37**	**9**	**-9.7**	**4.4**	**H.m.**	**3rd instar**	**Oct 1**	**07:00~**
St.2	**08°00'S**	**080°30'E**	**2**	**28**	**36**	**38**	**10**	**-11.6**	**7.0**	**H.g.**	**Adult(female)**	**Oct 1**	**07:00~**
St.2	**08°00'S**	**080°30'E**	**2**	**28**	**35**	**39**	**11**	**-12.1**	**5.0**	**H.m.**	**4th instar**	**Oct 1**	**07:00~**
St.2	**08°00'S**	**080°30'E**	**2**	**28**	**35**	**41**	**13**	**-16.8**	**8.9**	**H.g.**	**5th instar**	**Oct 1**	**07:00~**
St.3	**08°00'S**	**080°29'E**	**3**	**28**	**29**	**31**	**3**	**-16.4**	**8.5**	**H.m.**	**5th instar**	**Oct 2**	**06:45~**
St.3	**08°00'S**	**080°29'E**	**3**	**28**	**34**	**36**	**8**	**-14.6**	**5.2**	**H.m.**	**Adult (male)**	**Oct 2**	**06:45~**
St.3	**08°00'S**	**080°29'E**	**3**	**28**	**32**	**37**	**9**	**-18.4**	**10.6**	**H.m.**	**Adult (female)**	**Oct 2**	**06:45~**
St.3	**08°00'S**	**080°29'E**	**3**	**28**	**36**	**37**	**9**	**-15.5**	**5.4**	**H.m.**	**Adult (male)**	**Oct 2**	**06:45~**
St.3	**08°00'S**	**080°29'E**	**3**	**28**	**33**	**37**	**9**	**-15.9**	**9.2**	**H.m.**	**Adult (female)**	**Oct 2**	**06:45~**
St.3	**08°00'S**	**080°29'E**	**3**	**28**	**36**	**38**	**10**	**-14.8**	**8.5**	**H.m.**	**Adult (female)**	**Oct 2**	**06:45~**
St.3	**08°00'S**	**080°29'E**	**3**	**28**	**36**	**39**	**11**	**-16.2**	**8.4**	**H.m.**	**Adult(male)**	**Oct 2**	**06:45~**

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St.3	08º00'S	080º29'E	3	28	38	39	11	-15.4	7.2	H.m.	Adult(female)	Oct 2	06:45~
St.3	08º00'S	080º29'E	3	28	39	39	11	-15.1	8.7	H.m.	Adult(female)	Oct 2	06:45~
St.3	08º00'S	080º29'E	3	28	39	40	12	-15.5	9.0	H.m.	5th instar	Oct 2	06:45~
St.3	08º00'S	080º29'E	3	28	40	40	12	-11.5	4.5	H.m.	Adult(female)	Oct 2	06:45~
St.4	08º01'S	080º30'E	4	29	31	31	2	-19.6	4.8	H.m.	Adult(female)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	32	34	5	-16.7	8.0	H.m.	Adult(female)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	34	36	7	-13.2	4.4	H.m.	Adult(male)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	36	36	7	-15.6	4.7	H.m.	Adult(male)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	37	38	9	-13.5	5.8	H.m.	Adult(male)	Oct 4	07:00~

Table 4-Sheet 2. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis_(from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St.4	08º01'S	080º30'E	4	29	37	38	9	-19.3	8.3	H.m.	Adult (male)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	38	38	9	-15.2	6.1	H.m.	Adult(male)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	38	38	9	-14.1	6.1	H.m.	Adult(male)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	38	38	9	-14.1	5.5	H.m.	Adult (female)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	38	39	10	-13.8	9.0	H.m.	Adult (female)	Oct 4	07:00~
St.4	08º01'S	080º30'E	4	29	-	-	-	-17.0	1.5	H.m.	Adult(male)	Oct 4	1000-1400
St.4	08º01'S	080º30'E	4	29	-	-	-	-15.0	6.3	H.m.	Adult (female)	Oct 4	1000-1400
St.4	08º01'S	080º30'E	4	29	-	-	-	-14.7	3.4	H.m.	Adult (male)	Oct 4	1000-1400
St.4	08º01'S	080º30'E	4	29	-	-	-	-14.9	6.4	H.m.	Adult(female)	Oct 4	1000-1400
St.4	08º01'S	080º30'E	4	29	-	-	-	-18.3	10.1	H.m.	Adult (male)	Oct 4	1000-1400
St.4	08º01'S	080º30'E	4	29	-	-	-	-20.2	9.2	H.m.	Adult (male)	Oct 4	1000-1400

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St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-19.1**	**7.6**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**- 20.8**	**6.8**	**H.m.**	**Adult(male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.8**	**3.9**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-16.5**	**6.0**	**H.m.**	**Adult (male)**	**Oct 4**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.5**	**6.6**	**H.m.**	**Adult(male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-19.9**	**8.9**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-16.6**	**7.5**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-20.8**	**10.7**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**- 20.1**	**5.9**	**H.m.**	**Adult(male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.6**	**5.2**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.3**	**7.0**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-15.9**	**8.3**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.6**	**8.9**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.9**	**9.6**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**- 15.4**	**7.8**	**H.m.**	**Adult(male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.1**	**6.5**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.0**	**9.2**	**H.m.**	**Adult (male)**	**Oct 5**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.7**	**7.9**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-21.0**	**8.1**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**

Table 4-Sheet 3. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	**Latitude**	**Longitude**	**Exp.No.**	**TA**	**TSHP**	**THP**	**GTHP**	**SCP**	**ITSCP**	**Species**	**Stage (sex)**	**Date**	**TD**

.

St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-22.2**	**7.7**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.7**	**7.2**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-18.6**	**7.5**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-21.8**	**7.9**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-16.2**	**7.6**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-21.2**	**9.1**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-19.5**	**3.5**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-17.6**	**8.3**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.4	**08º01'S**	**080º30'E**	**4**	**29**	**-**	**-**	**-**	**-20.8**	**5.3**	**H.m.**	**Adult (male)**	**Oct 7**	**1000-1400**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**32**	**33**	**5**	**-14.4**	**5.8**	**H.m.**	**5th instar**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**37**	**38**	**10**	**-18.6**	**8.3**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**37**	**38**	**10**	**-16.5**	**6.6**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**38**	**38**	**10**	**-15.6**	**7.6**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**38**	**38**	**10**	**-18.8**	**8.1**	**H.m.**	**Adult (female)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-16.5**	**9.2**	**H.m.**	**Adult (male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-9.6**	**4.2**	**H.m.**	**Adult(male)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-12.0**	**9.1**	**H.m.**	**Adult(female)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**28**	**39**	**39**	**11**	**-13.7**	**7.0**	**H.m.**	**Adult (female)**	**Oct 5**	**06:50~**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-21.8**	**9.3**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00-12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-15.6**	**4.3**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00-12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-19.6**	**7.2**	**H.m.**	**Adult (female)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-21.0**	**10.6**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-21.3**	**6.9**	**H.m.**	**Adult (female)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-19.6**	**4.3**	**H.m.**	**Adult (male)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-19.4**	**8.6**	**H.m.**	**Adult(female)**	**Oct 8**	**08:00~12:00**
St.5	**08º00'S**	**080º30'E**	**5**	**29**	**-**	**-**	**-**	**-16.5**	**6.4**	**H.m.**	**Adult(female)**	**Oct 8**	**08:00~12:00**

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St.5	08º00'S	080º30'E	5	29	-	-	-	-17.0	7.0	H.m.	Adult (female)	Oct 8	08:00~12:00
St.5	08º00'S	080º30'E	5	29	-	-	-	-18.5	6.4	H.m.	Adult (female)	Oct 8	08:00~12:00
St.6	08˚00'N	080˚29' E	6	29	37	37	8	-16.1	9.9	H.m.	5th instar	Oct 7	06:45~
St.6	08º00'S	080º29'E	6	29	32	38	9	-15.6	9.6	H.m.	Adult (female)	Oct 7	06:45~

Table 4-Sheet 4. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St.6	08º00'S	080º29'E	6	29	33	38	9	-15.4	9.2	H.m.	Adult (male)	Oct 7	06:45~
St.6	08º00'S	080º29'E	6	29	32	38	9	-17.8	4.0	H.m.	4th instar	Oct 7	06:45~
St.6	08º00'S	080º29'E	6	29	33	39	10	-16.4	5.1	H.m.	4th instar	Oct 7	06:45~
St.6	08º00'S	080º29'E	6	29	32	39	10	-15.2	6.3	H.g.	Adult (female)	Oct 7	06:45~
St.6	08º00'S	080º29'E	6	29	33	39	10	-19.3	4.8	H.g.	Adult(male)	Oct 7	06:45~
St.6	08º00'S	080º29'E	6	29	40	41	12	-15.5	6.4	H.g.	Adult(female)	Oct 7	06:45~
St.6	08º00'S	080º29'E	6	29	32	>=38	>=9	-	-	H.g.	4th instar	Oct 7	06:45~
St.7	08˚00'N	080˚30'E	7	29	30	37	8	-16.0	9.5	H.m.	5th instar	Oct 8	06:45~
St.7	08˚00'N	080˚30'E	7	29	32	37	8	-15.9	6.4	H.m.	5th instar	Oct 8	06:45~
St.7	08˚00'N	080˚30'E	7	29	31	38	9	-15.8	9.5	H.g.	Adult (male)	Oct 8	06:45~
St.7	08˚00'N	080˚30'E	7	29	32	38	9	-16.3	6.3	H.m.	Adult (male)	Oct 8	06:45~
St.7	08˚00'N	080˚30'E	7	29	38	38	9	-14.4	11.7	H.m.	Adult (male)	Oct 8	06:45~
St.7	08˚00'N	080˚30'E	7	29	31	39	10	-18.5	7.3	H.g.	Adult (male)	Oct 8	06:45~
St.7	08˚00'N	080˚30'E	7	29	38	39	10	-19.4	6.9	H.g.	Adult(female)	Oct 8	06:45~
St.7	08˚00'N	080˚30'E	7	29	39	39	10	-18.5	5.0	H.g.	Adult(male)	Oct 8	06:45~

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St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**40**	**40**	**11**	**-11.8**	**5.0**	**H.g.**	**Adult(female)**	**Oct 8**	**06:45~**
St.7	**08˚00'N**	**080˚30'E**	**7**	**29**	**40**	**40**	**11**	**-12.5**	**0.5**	**H.g.**	**Adult (male)**	**Oct 8**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**32**	**36**	**7**	**-15.6**	**5.3**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**32**	**36**	**7**	**-15.0**	**6.7**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**37**	**37**	**8**	**-17.2**	**5.0**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**37**	**37**	**8**	**-16.2**	**4.6**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**38**	**9**	**-16.6**	**7.7**	**H.m.**	**Adult(male)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**38**	**9**	**-15.3**	**5.4**	**H.m.**	**5th instar**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**40**	**11**	**-15.0**	**5.3**	**H.m.**	**5th instar**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**38**	**40**	**11**	**-15.4**	**9.6**	**H.m.**	**5th instar**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**31**	**40**	**11**	**-17.0**	**3.1**	**H.g.**	**Adult(female)**	**Oct 10**	**06:45~**
St.8	**08˚00'N**	**080˚29'E**	**8**	**29**	**-**	**=>35**	**=>6**	**-**	**-**	**H.m.**	**4th instar**	**Oct 10**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**30**	**30**	**1**	**-16.1**	**8.4**	**H.m.**	**5th instar**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**32**	**36**	**7**	**-16.3**	**2.1**	**H.m.**	**Adult(male)**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**32**	**38**	**9**	**-16.3**	**6.2**	**H.m.**	**5th instar**	**Oct 11**	**06:45~**

Table 4-Sheet 5. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**37**	**39**	**10**	**-17.9**	**6.7**	**H.m.**	**Adult(male)**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**35**	**39**	**10**	**-16.3**	**7.6**	**H.m.**	**4th instar**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**37**	**39**	**10**	**-18.2**	**4.7**	**H.m.**	**Adult(male)**	**Oct 11**	**06:45~**
St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**38**	**40**	**11**	**-18.8**	**1.8**	**H.m.**	**Adult(male**	**Oct 11**	**06:45~**

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St.9	**08˚00'N**	**080˚29'E**	**9**	**29**	**37**	**40**	**11**	**-15.2**	**8.3**	**H.m.**	**Adult(female)**	**Oct 11**	**06:45~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-19.1**	**9.0**	**H.m.**	**Adult(female)**	**Oct 13**	**06:50~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-17.6**	**10.2**	**H.m.**	**Adult(female)**	**Oct 13**	**07:15~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-16.8**	**8.8**	**H.m.**	**Adult(male)**	**Oct 13**	**07:45~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-15.3**	**7.5**	**H.m.**	**Adult(female)**	**Oct 13**	**08:05~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-17.0**	**8.4**	**H.m.**	**5th instar**	**Oct 13**	**08:25~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-14.8**	**7.2**	**H.m.**	**5th instar**	**Oct 13**	**08:40~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-17.1**	**7.0**	**H.m.**	**5th instar**	**Oct 13**	**08:55~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**-**	**-**	**-**	**-15.3**	**4.9**	**H.m.**	**5th instar**	**Oct 13**	**09:10~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**33**	**38**	**9**	**-11.0**	**4.3**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**37**	**39**	**10**	**-21.0**	**8.6**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-16.3**	**7.1**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-20.9**	**9.2**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-18.6**	**6.2**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**38**	**39**	**10**	**-17.8**	**4.2**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**39**	**40**	**11**	**-12.9**	**1.5**	**H.m.**	**Adult(male)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**39**	**40**	**11**	**-16.9**	**6.9**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**40**	**40**	**11**	**-16.4**	**7.1**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 10	**08˚00'S**	**080˚29'E**	**10**	**29**	**40**	**40**	**11**	**-15.2**	**4.8**	**H.m.**	**Adult(female)**	**Oct 13**	**06:30~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**33**	**36**	**7**	**-19.0**	**10.7**	**H.m.**	**5th instar**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**32**	**37**	**8**	**-14.8**	**6.1**	**H.m.**	**Adult(female)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**37**	**38**	**9**	**-21.1**	**10.4**	**H.m.**	**Adult(female)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**40**	**40**	**11**	**-20.2**	**8.4**	**H.m.**	**5th instar**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**38**	**40**	**11**	**-17.9**	**7.8**	**H.m.**	**Adult(male)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**38**	**40**	**11**	**-12.3**	**5.2**	**H.m.**	**Adult(male)**	**Oct 14**	**06:35~**
St. 11	**08˚00'S**	**080˚29'E**	**11**	**29**	**38**	**40**	**11**	**-16.6**	**9.2**	**H.m.**	**Adult(female)**	**Oct 14**	**06:35~**

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Table 4-Sheet 6. Results of "heat-paralysis" experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St.11	08˚00'N	080˚29'E	11	29	39	40	11	-17.1	10.5	H.m.	Adult(female)	Oct 14	06:35~
St.11	08˚00'N	080˚29'E	11	29	33	41	12	-20.0	6.8	H.g.	5th instar	Oct 14	06:35~
St.11	08˚00'N	080˚29'E	11	29	30	41	12	-21.2	10.4	H.g.	Adult(female)	Oct 14	06:35~
St.13	08˚00'S	080˚29'E	13	29	-	-	-	-16.1	7.0	H.m.	5th instar	Oct 17	06:55~
St.13	08˚00'S	080˚29'E	13	29	-	-	-	-13.5	5.3	H.m.	5th instar	Oct 17	07:15~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-13.2	5.4	H.m.	5th instar	Oct 17	07:30~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-18.1	6.0	H.m.	5th instar	Oct 17	08:00~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-18.6	9.4	H.m.	5th instar	Oct 17	08:25~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-17.3	7.5	H.m.	5th instar	Oct 17	11:40~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-17.0	8.5	H.m.	5th instar	Oct 17	11:55~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-19.6	11.6	H.m.	5th instar	Oct 17	12:10~
St. 13	08˚00'S	080˚29'E	13	29	-	-	-	-15.4	6.3	H.m.	5th instar	Oct 17	13:00~
St. 12	08˚00'S	080˚29'E	12	29	35	35	6	-15.4	6.6	H.m.	Adult (female)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	31	37	8	-14.5	8.4	H.m.	Adult(male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	36	39	10	-16.5	7.3	H.m.	Adult(female)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	38	39	10	-18.7	6.0	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	38	40	11	-15.6	7.4	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	39	40	11	-21.4	9.1	H.m.	Adult (female)	Oct 16	06:45~
St. 12	08˚00'S	080˚29'E	12	29	40	40	11	-16.5	7.0	H.m.	Adult (male)	Oct 16	06:45~

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St. 12	08˚00’S	080˚29’E	12	29	40	40	11	-15.9	6.1	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00’S	080˚29’E	12	29	40	40	11	-17.8	8.3	H.m.	Adult (male)	Oct 16	06:45~
St. 12	08˚00’S	080˚29’E	12	29	39	41	12	-17.9	5.7	H.m.	Adult (female)	Oct 16	06:45~
St. 13	08˚00’S	080˚29’E	13	29	37	39	10	-16.3	8.7	H.m.	Adult(male)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	36	39	10	-15.7	6.8	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	38	39	10	-17.5	9.4	H.m.	Adult (male)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	39	40	11	-16.6	7.5	H.m.	Adult (male)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	38	40	11	-9.1	3.6	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	39	40	11	-15.8	5.9	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	39	40	11	-16.3	4.8	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	39	41	12	-15.4	4.9	H.m.	Adult (male)	Oct 17	06:45~

Table 4-Sheet 7. Results of “heat-paralysis” experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from base temp.); “Date and Time of day” when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St. 13	08˚00’S	080˚29’E	13	29	40	41	12	-17.3	7.9	H.m.	Adult (female)	Oct 17	06:45~
St. 13	08˚00’S	080˚29’E	13	29	39	41	12	-16.0	4.8	H.m.	Adult(male)	Oct 17	06:45~
St. 14	07º59’S	080º29’E	14	29	39	39	10	-20.4	8.6	H.m.	Adult (male)	Oct 19	06:30~
St. 14	07º59’S	080º29’E	14	29	38	39	10	-18.4	6.5	H.m.	Adult(female)	Oct 19	06:30~
St. 14	07º59’S	080º29’E	14	29	39	39	10	-18.8	6.1	H.m.	Adult(male)	Oct 19	06:30~
St. 14	07º59’S	080º29’E	14	29	39	40	11	-20.3	10.3	H.m.	Adult (female)	Oct 19	06:30~
St. 14	07º59’S	080º29’E	14	29	39	40	11	-20.8	10.3	H.m.	Adult (male)	Oct 19	06:30~
St. 14	07º59’S	080º29’E	14	29	41	41	12	-18.1	9.0	H.m.	Adult (female)	Oct 19	06:30~

St. 14	07°59’S 080°29’E	14	29	41	41	12	-18.6	8.8	H.m.	Adult (female)	Oct 19	06:30~
St. 15	07°59’S 080°30’E	15	29	31	40	11	-18.1	9.9	H.m.	5th instar	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	37	40	11	-19.4	5.1	H.m.	5th instar	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	35	40	11	-	-	H.m.	Adult (male)	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	40	40	11	-15.8	2.2	H.m.	5th instar	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	35	40	11	-12.3	7.6	H.m.	Adult(female)	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	37	40	11	-17.6	0.8	H.m.	Adult(female)	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	39	40	11	-12.6	5.2	H.m.	Adult (female)	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	39	41	12	-15.6	4.3	H.m.	Adult(female)	Oct 20	06:45~
St. 15	07°59’S 080°30’E	15	29	36	41	12	-16.1	4.0	H.g.	Adult(male)	Oct 20	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	32	38	9	-14.2	7.8	H.m.	Adult(female)	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	36	39	10	-18.1	9.0	H.m.	5th instar	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	37	39	10	-13.8	6.6	H.m.	5th instar	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	39	40	11	-19.2	9.1	H.m.	5th instar	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	37	40	11	-20.0	10.7	H.m.	Adult(female)	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	39	40	11	-	-	H.m.	5th instar	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	39	40	11	-19.1	8.2	H.m.	5th instar	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	39	41	12	-16.3	6.1	H.m.	Adult(female)	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	40	41	12	-18.6	7.3	H.m.	5th instar	Oct 22	06:45~
St. 16	07˚59’S 080˚29’ E	16	29	41	41	12	-8.1	0.6	H.m.	Adult(female)	Oct 22	06:45~
St. 17	08˚00’S 080˚29’E	17	29	30	40	11	-11.0	5.0	H.g.	Adult(female)	Oct 23	06:45~
St. 17	08˚00’S 080˚29’E	17	29	37	40	11	-17.6	5.2	H.m.	5th instar	Oct 23	06:45~

Table 4-Sheet 8. Results of “heat-paralysis” experiments and SCP (Super Cooling Point) measurement performed on adults of *Halobates micans* (H.m.) and *H. germanus* (H.g.); TA: temp. at which specimen adapted, TSHP: temp. at which semi-heat paralysis occurred; THP: temp. at which heat-paralysis occurred ; GTHP: gap temp. for heat paralysis (from

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base temp.); "Date and Time of day" when experiments were performed. (MR-11-04-Leg 1: Sep. 28-Oct 23, 2011), ITSCP: Increased temperature at SCP was detected; TD: Time of day when heat-paralysis experiment was performed

St.No.	Latitude	Longitude	Exp.No.	TA	TSHP	THP	GTHP	SCP	ITSCP	Species	Stage (sex)	Date	TD
St. 17	08˚00'S	080˚29'E	17	29	38	40	11	-14.1	6.8	H.m.	Adult (female)	Oct 23	06:45~
St. 17	08˚00'S	080˚29'E	17	29	40	40	11	-14.9	9.3	H.m.	5th instar	Oct 23	06:45~
St. 17	08˚00'S	080˚29'E	17	29	41	41	12	-8.6	5.3	H.m.	5th instar	Oct 23	06:45~
St. 17	08˚00'S	080˚29'E	17	29	41	41	12	-11.0	0.5	H.m.	5th instar	Oct 23	06:45~
St. 17	08˚00'S	080˚29'E	17	29	41	41	12	-11.6	4.1	H.g.	Adult (female)	Oct 23	06:45~

Table 5-A. Comparison of Temperature for Heat Semi-Coma Temperature (HSCT), Heat Coma Temperature (HCT), Gap Temperature for Heat Coma (GTHC), Super-Cooling Temperature (SCP) and Increased Temperature at Super Cooling Point (ITSCP) between *Halobates micans* and *H. germanus*. Experiments were performed in the period of 28 Sep to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

.	HSCT	HCT	GTHC	SCP	ITSCP
H .micans	36.8±2.9(125)	38.4±2.4(133)	9.7±2.2(133)	-16.0±2.7(131)	6.8±2.3(131)
H. germanus	34.9±3.9(18)	39.8±1.1(20)	11.0±1.2(20)	-15.7±3.3(19)	6.0±2.3(19)
Total	36.6±3.1(143)	38.6±2.3(153)	9.8±2.2(153)	-16.0±2.8(150)	6.7±2.3(150)
Mann-Whitney U-test between H. micans and H. germanus					
Z	*-1.889*	*-2.848*	*-2.718*	*-0.339*	*-1.382*
P	*0.059*	*0.004*	*0.007*	*0.735*	*0.167*

Table 5-B. Comparison of Temperature for Heat Semi-Coma Temperature (HSCT), Heat Coma Temperature (HCT), Gap Temperature for Heat Coma (GTHC), Super-Cooling Temperature (SCP) and Increased Temperature at Super Cooling Point (ITSCP) between females and males in mostly *Halobates micans* and partically *H.germanus*. Experiments were performed in the period of 28 Sep to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

Adult stage	**HSCT**	**HCT**	**GTHC**	**SCP**	**ITSCP**

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Females	37.0±3.1(55)	38.9±2.4(61)	10.2±2.3(61)	-15.6±3.1(61)	6.8±2.3(61)
Males	36.7±2.6(54)	38.4±1.8(57)	9.6±1.7(57)	-16.3±2.3(56)	6.3±2.3(56)
Total	36.9±2.9(109)	38.6±2.2(118)	9.9±2.1(118)	-15.9±2.8(117)	6.6±2.3(117)
Mann-Whitney U-test between females and males					
Z	*-1.178*	*-2.870*	*-3.149*	*-1.332*	*-1.356*
P	*0.239*	*0.004*	*0.002*	*0.183*	*0.175*

Table 5-C. Comparison of Temperature for Heat Semi-Coma Temperature (HSCT), Heat Coma Temperature (HCT), Gap Temperature for Heat Coma (GTHC), Super-Cooling Temperature (SCP) and Increased Temperature at Super Cooling Point (ITSCP) among 3rd to 5th larval instars and adult stages in mostly *Halobates micans* and partically *H.germanus*. Experiments were performed in the period of 28 Sep to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

	HSCT	HCT	GTHC	SCP	ITSCP	
Adults	36.9±2.9(109)	38.6±2.2(118)	9.9±2.1(118)	-15.9±2.8(117)	6.6±2.3(117)	
5th instars	36.2±3.7(28)	38.6±2.9(29)	9.7±2.8(29)	-16.3±2.6(28)	7.3±2.4(28)	
4th instars	33.4±1.5(5)	38.6±0.5(5)	9.8±0.8(5)	-15.7±2.5(4)	5.4±1.5(4)	
3rd instar	35(1)	37(1)	9.0	-9.7(1)	4.4(1)	
Total	36.6±3.1(143)	38.6±2.3(153)	9.8±2.2(153)	-16.0±2.8(150)	6.7±2.3(150)	
Kruskal-Wallis-test among stages						
X^2 value	*5.966*	*1.528*	*1.015*	*0.453*	*5.539*	
df	*2*	*2*	*2*	*2*	*2*	
P	*0.051*	*0.466*	*0.602*	*0.797*	*0.063*	***One-Way ANOVA***
F	*2.407*	*0.175*	*0.085*	*1.950*	*1.490*	
df	*3*	*3*	*3*	*3*	*3*	
P	*0.070*	*0.913*	*0.968*	*0.124*	*0.220*	

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Table 6. Effect of the application of Heat Coma Experiment (HC exp.) before measuring Super-Cooling Point (SCP) and Increased Temperature at SCP (ITSCP) on these two values. Data on the specimens collected at around 08º00'S, 080º30'E (Stations 2-17) were analyzed. Experiments were performed in the period of 1st Oct to 23rd Oct, 2011 in the wet-laboratory 2 of R/V Mirai during the cruise of MR-11-07 [Mean±SD(n)]

	Stage			
	5th Instar		Adult	
	SCP	ITSCP	SCP	ITSCP
After HC exp.	-16.4±2.6(27)	7.3±2.4(27)	-16.1±2.7(108)	6.7±2.3(108)
Without HC exp.	-16.4±1.9(13)	7.3±1.9(13)	-18.4±2.0(48)	7.3±2.0(48)
Mann-Whitney U-test				
Z	*-0.231*	*-0.448*	*-4.897*	*-1.740*
P	*0.817*	*0.669*	*<0.001*	*0.082*

Table 7-Sheet 1. Results of salinity experiment (Experiment 1) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.6Cº; Air Temperature: 29.5Cº

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.18-24	08˚00'S	080˚30'E	1	12	H. m.	5th instar	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	15	H. m.	Adult (male)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	51	H. m.	Adult (male)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	63	H. m.	Adult (female)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	109	H. m.	Adult (female)	Nov 8	A
St.18-24	08˚00'S	080˚30'E	1	2	H. m.	5th instar	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	17	H. m.	Adult (female)	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	25	H. m.	Adult (female)	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	29	H. m.	Adult (male)	Nov 8	B

St.18-24	08˚00'S	080˚30'E	1	32	H. m.	Adult (male)	Nov 8	B
St.18-24	08˚00'S	080˚30'E	1	13	H. m.	Adult (male)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	19	H. m.	Adult (female)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	23	H. m.	Adult (female)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	25	H. m.	Adult (male)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	29	H. m.	Adult (female)	Nov 8	C
St.18-24	08˚00'S	080˚30'E	1	6	H. m.	Adult (male)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	7	H. m.	Adult (male)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	8	H. m.	Adult (female)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	9	H. m.	Adult (female)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	9	H. m.	5th instar	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	25	H. m.	Adult (female)	Nov 8	D
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (female)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (female)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	7	H. m.	Adult (female)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	7	H. m.	Adult (male)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	8	H. m.	Adult (male)	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	12	H. m.	5th instar	Nov 8	E
St.18-24	08˚00'S	080˚30'E	1	3	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	3	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	4	H. m.	Adult (male)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	5	H. m.	Adult (female)	Nov 8	F
St.18-24	08˚00'S	080˚30'E	1	5	H. m.	Adult (male)	Nov 8	F

Table 7-Sheet 2. Results of salinity experiment (Experiment 2) performed on larvae and adults of

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Halobates micans (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.8C°; Air Temperature: 29.6C°

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	5th instar	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	15	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	21	H. m.	Adult (male)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	30	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	37	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	45	H. m.	Adult (male)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	>48	H. m.	Adult (female)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	>48	H. m.	Adult (male)	Nov 13	A
St.25-28	08˚00'S	080˚30'E	2	15	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	25	H. m.	Adult (male)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	29	H. m.	5th instar	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	37	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	39	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	41	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	46	H. m.	Adult (female)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	>48	H. m.	Adult (male)	Nov 13	B
St.25-28	08˚00'S	080˚30'E	2	5	H. m.	5th instar	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (male)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	12	H. m.	Adult (female)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	16	H. m.	Adult (female)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	19	H. m.	Adult (female)	Nov 13	C

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St.25-28	08˚00'S	080˚30'E	2	27	H. m.	Adult (male)	Nov 13	C
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	Adult (female)	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	5^{th} instar	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	7	H. m.	Adult (female)	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (male)	Nov 13	D
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	9	H. m.	Adult (male)	Nov 13	D
St.18-24	08˚00'S	080˚30'E	2	2	H. m.	Adult (female)	Nov 13	E

Table 7-Sheet 3. Results of salinity experiment (Experiment 2) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.8C°; Air Temperature: 29.6C°

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	Adult (female)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	5	H. m.	Adult (male)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	5	H. m.	Adult (male)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (female)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	7	H. m.	Adult (male)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	Adult (female)	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	8	H. m.	5^{th} instar	Nov 13	E
St.25-28	08˚00'S	080˚30'E	2	2	H. m.	5^{th} instar	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	Adult (female)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	3	H. m.	5^{th} instar	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	4	H. m.	Adult (female)	Nov 13	F

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St.25-28	08˚00'S	080˚30'E	2	5	H. m.	Adult (male)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (male)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (male)	Nov 13	F
St.25-28	08˚00'S	080˚30'E	2	6	H. m.	Adult (female)	Nov 13	F

Table 7-Sheet 4. Results of salinity experiment (Experiment 2) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, A': 9‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.6Cº; Air Temperature: 29.6Cº

St.No.	Latitude(N)	Longitude(E)	Exp.No.	HS	Species	Stage (sex)	Date	Salinity conc..
St.29-34	08˚00'S	080˚30'E	3	29	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	42	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	44	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	62	H. m.	Adult (male)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	64	H. m.	Adult (female)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	89	H. m.	Adult (female)	Nov 22	A
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	17	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	25	H. m.	Adult (male)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	31	H. m.	Adult (male)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	38	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	62	H. m.	Adult (male)	Nov 22	A'
St.18-24	08˚00'S	080˚30'E	3	72	H. m.	Adult (female)	Nov 22	A'
St.29-34	08˚00'S	080˚30'E	3	20	H. m.	Adult (male)	Nov 22	B
St.29-34	08˚00'S	080˚30'E	3	29	H. m.	Adult (female)	Nov 22	B
St.29-34	08˚00'S	080˚30'E	3	36	H. m.	Adult (female)	Nov 22	B

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St.29-34	**08˚00'S**	**080˚30'E**	**3**	**37**	**H. m.**	**Adult (female)**	**Nov 22**	**B**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**50**	**H. m.**	**Adult (female)**	**Nov 22**	**B**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**12**	**H. m.**	**Adult (female)**	**Nov 22**	**C**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**14**	**H. m.**	**Adult (female)**	**Nov 22**	**C**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**16**	**H. m.**	**Adult (female)**	**Nov 22**	**C**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**25**	**H. m.**	**Adult (male)**	**Nov 22**	**C**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**26**	**H. m.**	**Adult (male)**	**Nov 22**	**C**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**28**	**H. m.**	**Adult (male)**	**Nov 22**	**C**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**2**	**H. m.**	**Adult (female)**	**Nov 22**	**D**
St.18-24	**08˚00'S**	**080˚30'E**	**2**	**2**	**H. m.**	**Adult (female)**	**Nov 22**	**D**
St.18-24	**08˚00'S**	**080˚30'E**	**2**	**3**	**H. m.**	**Adult (male)**	**Nov 13**	**D**
St.18-24	**08˚00'S**	**080˚30'E**	**2**	**4**	**H. m.**	**Adult (female)**	**Nov 13**	**D**
St.18-24	**08˚00'S**	**080˚30'E**	**2**	**4**	**H. m.**	**Adult (male)**	**Nov 13**	**D**
St.18-24	**08˚00'S**	**080˚30'E**	**2**	**8**	**H. m.**	**Adult (male)**	**Nov 13**	**D**

Table 7-Sheet 5. Results of salinity experiment (Experiment 2) performed on larvae and adults of *Halobates micans* (H. m.) HS: hours in survival under starvation on one of 5 brackish or fresh waters with six salinity concentrations (A: sea water, 10‰, A': 9‰, B: 8‰, C: 6‰, D: 4‰, E: 2‰, F: 0‰) ; "Date" when experiments started. (MR-11-07-Leg2: Oct 28-Dec 2, 2011) Water temperature: 28.6C°; Air Temperature: 29.6C°

St.No.	**Latitude(N)**	**Longitude(E)**	**Exp.No.**	**HS**	**Species**	**Stage (sex)**	**Date**	**Salinity conc..**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**2**	**H. m.**	**Adult (female)**	**Nov 22**	**E**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**2**	**H. m.**	**Adult (female)**	**Nov 22**	**E**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**3**	**H. m.**	**5^{th} instar**	**Nov 22**	**E**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**4**	**H. m.**	**Adult (male)**	**Nov 22**	**E**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**4**	**H. m.**	**Adult (male)**	**Nov 22**	**E**
St.29-34	**08˚00'S**	**080˚30'E**	**3**	**5**	**H. m.**	**Adult (male)**	**Nov 22**	**E**

.

St.29-34	08˚00'S	080˚30'E	3	5	H. m.	Adult (female)	Nov 22	E
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (female)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	2	H. m.	Adult (male)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	3	H. m.	Adult (female)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	4	H. m.	Adult (female)	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	5	H. m.	Adult (male)	Nov 22	F
St.18-24	08˚00'S	080˚30'E	3	5	H. m.	5^{th} instar	Nov 22	F
St.29-34	08˚00'S	080˚30'E	3	6	H. m.	Adult (male)	Nov 22	F

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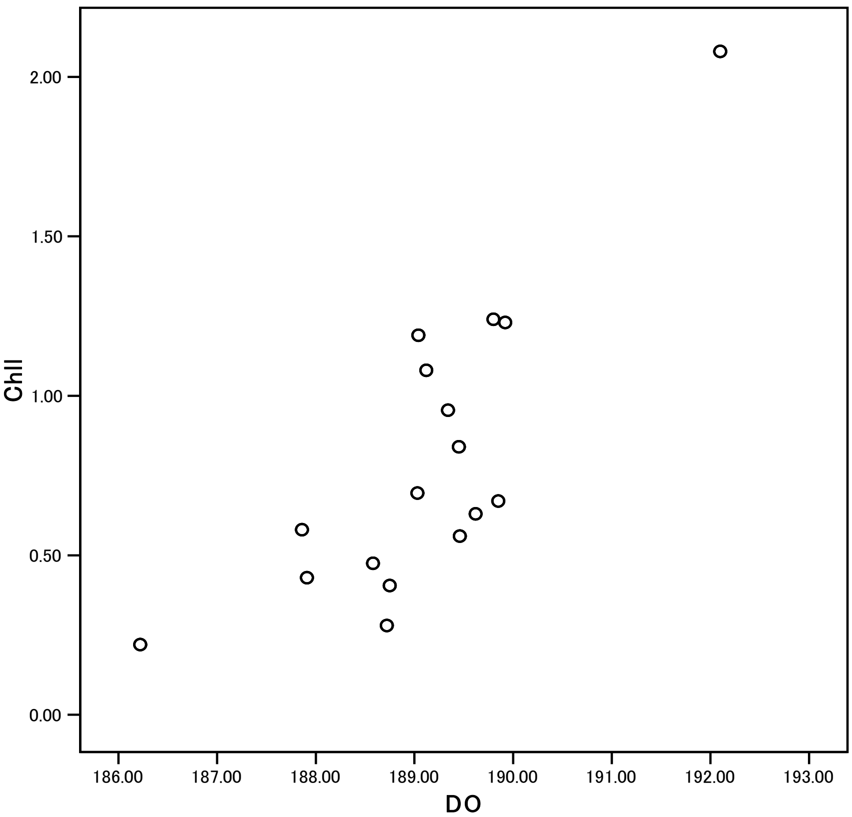

Fig.1 : Positive correlation between dissolved oxygen (μmol/kg) and chlorophyll (relative fluorescent value) contents in surface sea water. Very clear positive correlation can be seen (Pearson's correlation test: $r=0.803$, $p<0.001$, $n=51$). Such positive correlation means very low contents ratio of animals in comparison with plants.

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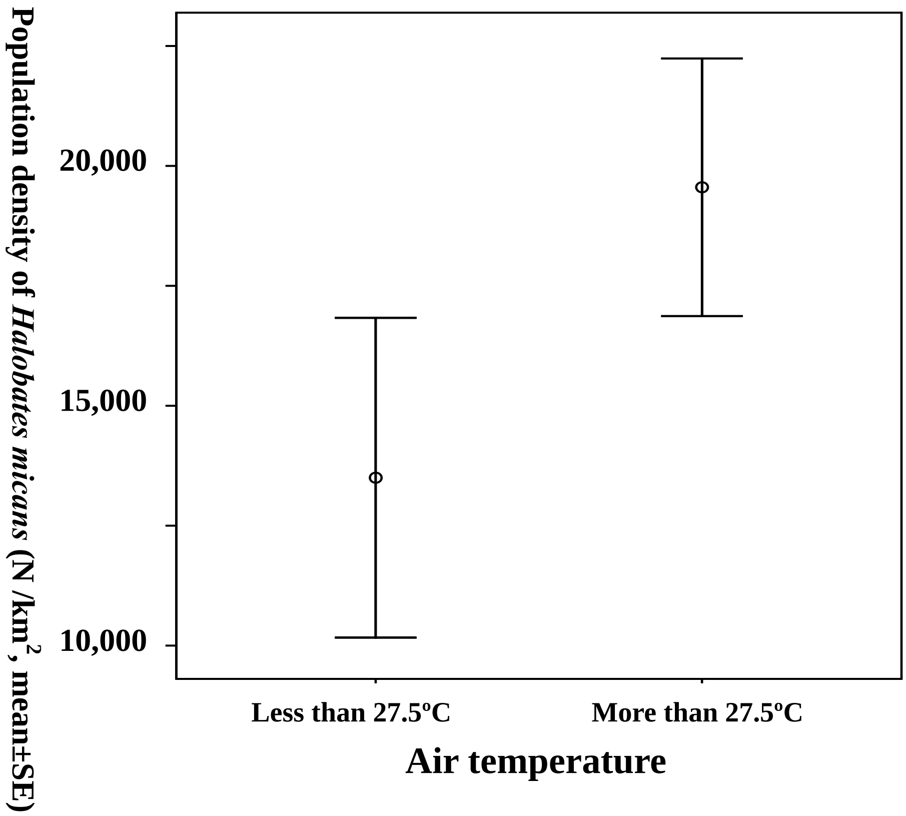

Fig.2: Comparison of population density (number of individuals in all larval and adult stages / km^2) of *Halobates micans* when air temperature was more than 27.5 ºC at sampling site to the population density when it was less than 27.5ºC.

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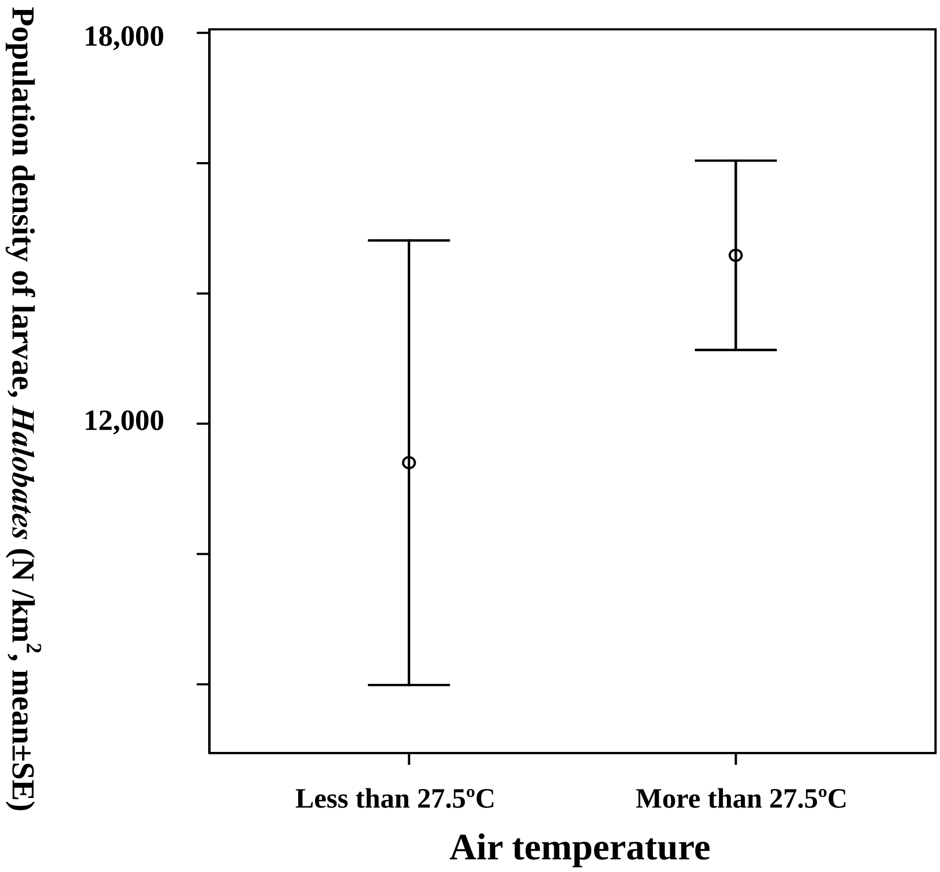

Fig.3: Comparison of population density (number of individuals / km^2) of larvae of *Halobates* (mostly *H. micans;* plus *H. germanus*) when air temperature was more than 27.5 ºC at sampling site to the population density when it was less than 27.5ºC.

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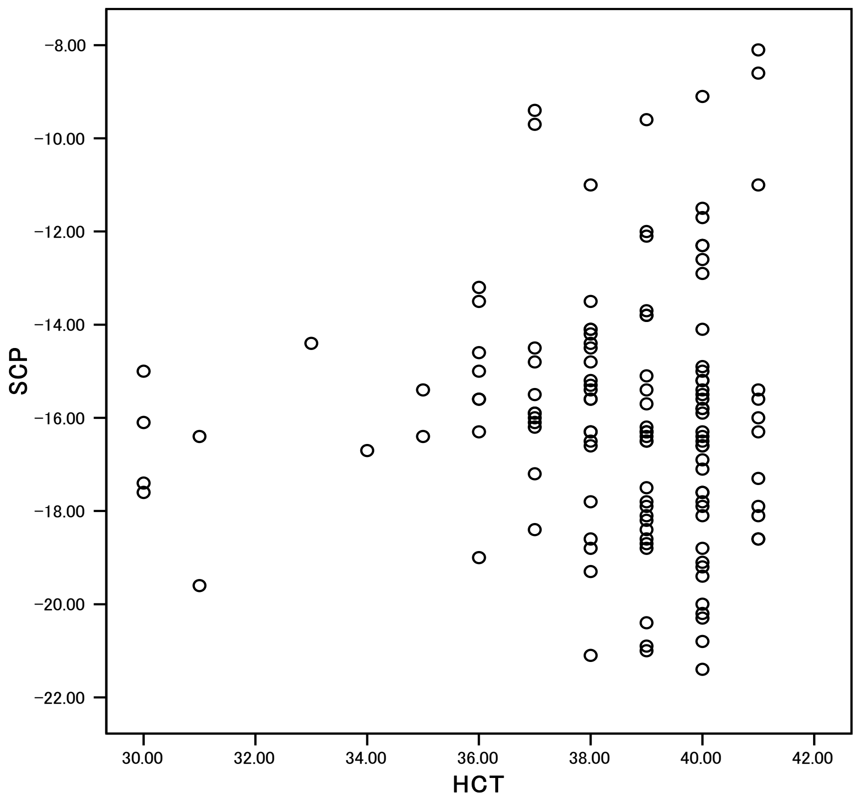

Fig. 4: Correlative analysis of Super-cooling point (SCP) and Heat Coma Temperature shown by all specimens of *Halobates micans* collected at Stations 1-17 and applied to these measurements No correlation was shown (Pearson's correlation test: r=0.013, p=0.883, n=131).

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Photo 1: A trailing scene of Neuston-NET

Photo 2: Washing the "pants" of the Neuston net just after the trailing to collect all *Halobates* individuals into the round-shaped transparent aquarium.

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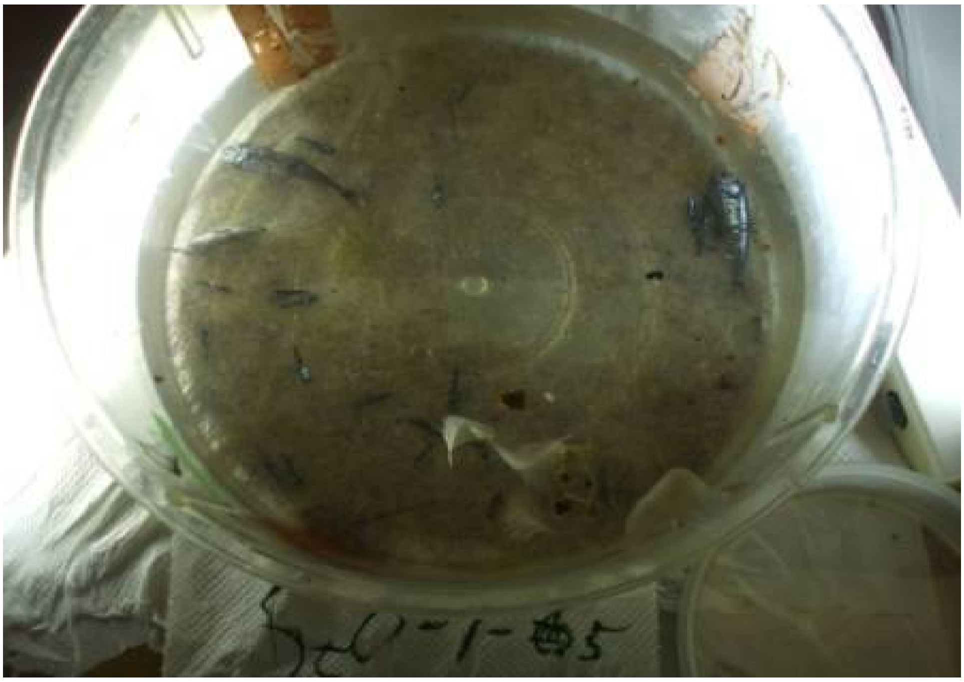

Photo 3: An example of the sample of Neuston-NET trailing.

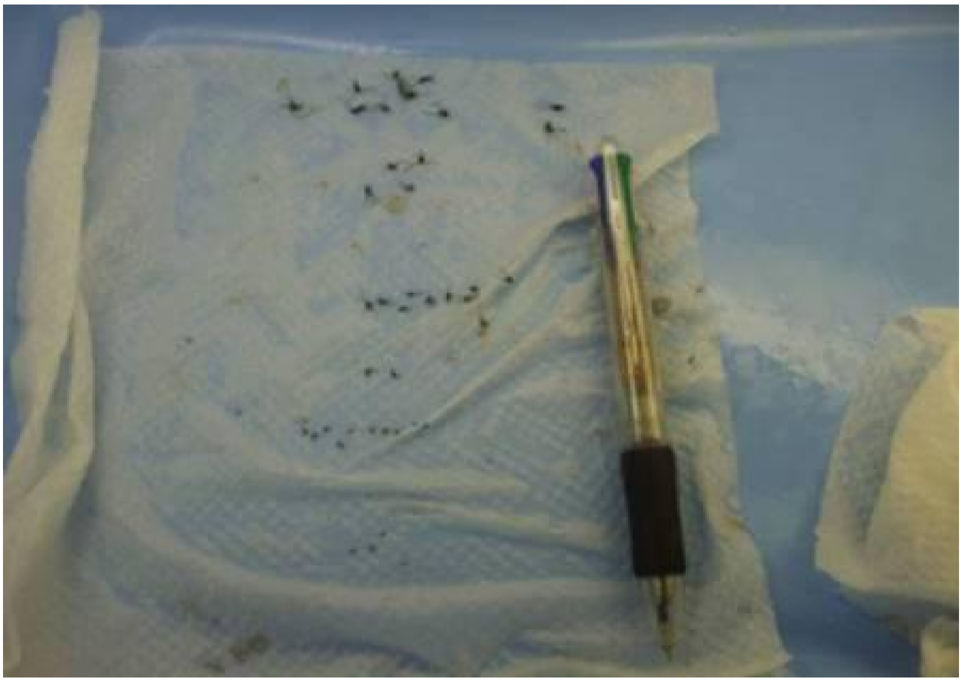

Photo 4: Example of larval and adult individuals of *Halobates* collected by a Neuston Net Sampling for 15min.

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Photo 5: An example of scene showing the heat paralysis experiment arena (on the left) and incubating aquaria filled with sea water Air and sea water temperature was kept within 29±2℃ with air-conditioners or a heater.

Photo 6: A scene of measuring super cooling point (SCP) with automatic temperature recorders with a thermo-sensor consisting of nickel-bronze coupling and freezer in which temperature was kept at -35℃. When heat coma occurred for a specimen applied to the Heat Coma Experiment, ventral surface of thespecimen's thorax and abdomen was attached with the thermo-coupling at ventral surface of abdomen. Then the specimen was transferred into a box made of high-dense-type-polystyrene-form (another box can be seen on the freezer) and put into the freezer to measure SCP and ITSCP. See text for the detailed.

5.27 Stable water isotope observation

(1) Personnel

Naoyuki Kurita (JAMSTEC) - Principal Investigator (not on-board)

(2) Objective

It is well known that the variability of stable water isotopes (HDO and $H_2^{18}O$) is closely related with the moisture origin and hydrological processes during the transportation from the source region to deposition site. Thus, water isotope tracer is recognized as the powerful tool to study of the hydrological cycles in the atmosphere. However, oceanic region is one of sparse region of the isotope data, it is necessary to fill the data to identify the moisture sources by using the isotope tracer. In this study, to fill this sparse observation area, intense water isotopes observation was conducted along the cruise track of MR11-07.

(3) Method

Following observation was carried out throughout this cruise.

- Atmospheric moisture sampling:

Ambient air sampling was conducted using both latest laser based water vapor isotope analyzer (WVIA) and conventional cryogenic cold trap method. We used different air-sampling tube lines for each sampling. Both air-sampling lines connected at the middle level (20m above the sea level) of the mast at the compass deck to the laboratory. Air was drawn by external pump at a flow rate of 2 Lmin-1 for laser instrument and 1.5Lmin-1 for cold trap method. As for laser based measurement, every 50 minutes, the 3-way valve in the instrument automatically switched from ambient inlet to WVISS reference air, and then reference air with a H2O mixing ratio of 10000 ppmv was introduced to the WVIA during 10 minutes. After finishing reference gas measurement, the valve switches back to ambient inlet and ambient air sampling is resumed. The WVIA can measure HDO and H218O in the water vapor every second.

As for collection of vapor samples in cold trap, sampled air was passed through a glass trap in an ethanol bath, which was thermoelectrically cooled to -100 degree C. It is collected every 12 hour during the cruise. Amount of cold-trapped vapor was between 20 and 30g. After collection, water in the trap was subsequently thawed and poured into the 6ml glass bottle.

- Rainwater sampling

Rainwater samples gathered in rain/snow collector were collected just after precipitation events have ended. The collected sample was then transferred into glass bottle (6ml) immediately after the measurement of precipitation amount.

- Surface seawater sampling

Seawater sample taken by the pump from 4m depth were collected in glass bottle (6ml) around the noon at the local time.

(4) Water samples for isotope analysis

Sampling of water vapor for isotope analysis is summarized in Table 5.27-1 (127 samples). The detail of rainfall sampling (32 samples) is summarized in Table 5.27-2. Described rainfall amount is calculated from the collected amount of precipitation. Sampling of surface seawater taken by pump from 4m depths is summarized in Table 5.27-3 (63 samples).

(5) Data archive

The isotopic data of water vapor can obtain from the laser based water vapor isotope analyzer on board. The archived raw observed data was submitted to JAMSTEC Data Integration and Analysis Group (DIAG) after the cruise immediately. As for collected water samples, isotopes (HDO, $H_2{}^{18}O$) analysis will be done at RIGC/JAMSTEC, and then analyzed isotopes data will be submitted to JAMSTEC DIAG.

(6) Acknowledgment

The operations were supported by Global Ocean Development Inc.

Table 5.27-1 Summary of water vapor sampling for isotope analysis

Sample	Date	Time (UT)	Date	Time (UT)	Lon	Lat	T.M. (m^3)	Sam. (ml)	H2O ppm
V-1	9.25	12:25	9.26	01:29	89-09.5E	02-12.4N	1.75	36.0	25600
V-2	9.26	01:30	9.26	12:59	87-18.3E	00-51.3N	1.56	32.0	25527
V-3	9.26	13:00	9.27	02:01	85-09.6E	00-39.4S	1.75	36.4	25884
V-4	9.27	02:04	9.27	14:00	83-23.7E	01-56.3S	1.39	28.5	25516
V-5	9.27	14:05	9.28	02:04	81-28.5E	03-18.8S	1.27	26.0	25477
V-6	9.28	02:10	9.28	14:00	79-41.1E	04-23.8S	1.27	26.0	25477
V-7	9.28	14:04	9.29	02:00	78-22.6E	05-07.7S	1.26	25.5	25185
V-8	9.29	02:03	9.29	14:00	78-47.2E	05-56.0S	1.25	26.0	25884
V-9	9.29	14:01	9.30	02:05	80-20.9E	07-48.4S	1.22	24.0	24481
V-10	9.30	02:07	9.30	14:00	80-30.6E	08-00.7S	1.19	22.0	23007
V-11	9.30	14:01	10.1	02:02	80-31.0E	08-00.4S	1.21	23.2	23860
V-12	10.1	02:04	10.1	14:00	80-30.2E	07-59.7S	1.20	23.1	23956
V-13	10.1	14:02	10.2	02:35	80-30.3E	07-59.8S	1.26	24.0	23704
V-14	10.2	02:37	10.2	14:00	80-30.8E	08-01.0S	1.15	22.0	23807
V-15	10.2	14:02	10.3	02:00	80-30.9E	08-00.9S	1.20	20.2	20948
V-16	10.3	02:02	10.3	14:00	80-30.5E	08-00.4S	1.17	21.0	22336
V-17	10.3	14:02	10.4	04:36	80-31.0E	08-01.2S	1.47	26.4	22349
V-18	10.4	04:40	10.4	14:00	80-30.5E	07-59.6S	0.94	18.0	23830
V-19	10.4	14:02	10.5	02:00	80-30.1E	08-00.6S	1.21	22.2	22832
V-20	10.5	02:02	10.5	14:00	80-29.6E	08-00.1S	1.21	23.8	24478
V-21	10.5	14:02	10.6	02:00	80-30.1E	08-00.8S	1.21	21.8	22421
V-22	10.6	02:02	10.6	14:00	80-30.0E	08-00.1S	1.21	23.5	24169
V-23	10.6	14:01	10.7	02:01	80-30.8E	08-01.1S	1.21	23.0	23655
V-24	10.7	02:02	10.7	14:00	80-29.9E	07-59.7S	1.22	23.8	24277
V-25	10.7	14:02	10.8	02:00	80-31.2E	08-00.7S	1.22	22.2	22645
V-26	10.8	02:01	10.8	14:00	80-30.9E	08-01.0S	1.23	23.0	23270
V-27	10.8	14:02	10.9	02:00	80-30.5E	08-01.0S	1.23	22.4	22663
V-28	10.9	02:01	10.9	14:01	80-29.9E	07-59.9S	1.12	20.1	22333
V-29	10.9	14:03	10.10	02:00	80-30.6E	08-00.7S	1.17	22.6	24038
V-30	10.10	02:00	10.10	14:00	80-30.1E	08-00.0S	1.17	22.0	23400
V-31	10.10	14:00	10.11	02:00	80-30.4E	08-00.9S	1.17	21.8	23187
V-32	10.11	02:01	10.11	14:00	80-30.7E	08-00.4S	1.17	19.5	20741
V-33	10.11	14:01	10.12	02:00	80-30.6E	08-00.4S	1.17	20.0	21273
V-34	10.12	02:01	10.12	14:00	80-30.3E	07-59.6S	1.17	21.3	22655
V-35	10.12	14:02	10.13	02:01	80-31.1E	08-00.5S	1.17	20.0	21273
V-36	10.13	02:05	10.13	14:00	80-29.9E	08-00.2S	1.16	21.0	22529
V-37	10.13	14:02	10.14	02:01	80-30.9E	08-00.5S	1.17	21.4	22762
V-38	10.14	02:02	10.14	14:00	80-31.0E	08-00.5S	1.17	22.1	23506
V-39	10.14	14:02	10.15	02:02	80-30.7E	08-00.3S	1.17	22.2	23613
V-40	10.15	02:04	10.15	14:01	80-30.0E	07-59.6S	1.17	24.0	25527
V-41	10.15	14:02	10.16	02:00	80-30.9E	08-00.4S	1.17	22.0	23400
V-42	10.16	02:01	10.16	14:00	80-30.5E	07-59.7S	1.18	24.1	25416
V-43	10.16	14:02	10.17	02:01	80-30.2E	08-00.9S	1.18	22.0	23202
V-44	10.17	02:02	10.17	14:00	80-30.6E	08-00.7S	1.18	21.8	22991

V-45	10.17	14:02	10.18	02:00	80-30.7E	08-01.0S	1.15	21.4	23157
V-46	10.18	02:02	10.18	14:00	80-30.1E	07-59.9S	1.14	22.0	24016
V-47	10.18	14:01	10.19	02:00	80-30.9E	08-00.6S	1.15	21.0	22725
V-48	10.19	02:02	10.19	14:00	80-30.8E	07-59.5S	1.14	20.9	22815
V-49	10.19	14:02	10.20	02:00	80-31.2E	08-00.7S	1.14	20.0	21832
V-50	10.20	02:01	10.20	14:00	80-31.5E	07-59.3S	1.14	22.0	24016
V-51	10.20	14:02	10.21	02:00	80-31.3E	07-59.2S	1.14	21.8	23797
V-52	10.21	02:02	10.21	14:00	80-30.7E	07-59.6S	1.14	22.5	24561
V-53	10.21	14:02	10.22	02:00	80-30.8E	08-00.3S	1.14	22.0	24016
V-54	10.22	02:01	10.22	14:01	80-30.4E	07-59.5S	1.14	21.8	23797
V-55	10.22	14:02	10.23	02:00	80-31.5E	07-59.7S	1.14	19.8	21614
V-56	10.23	02:00	10.23	14:00	80-31.3E	07-59.9S	1.14	20.2	22051
V-57	10.23	14:02	10.24	02:00	80-31.6E	07-59.8S	1.14	20.4	22269
V-58	10.24	02:02	10.24	14:00	80-29.8E	06-15.8S	1.14	20.5	22378
V-59	10.24	14:01	10.25	2;00	80-30.1E	03-19.7S	1.15	21.4	23157
V-60	10.25	02:03	10.25	15:00	80-04.9E	00-16.7S	1.23	24.5	24788
V-61	10.25	15:01	10.26	00:00	NAN	NAN	0.86	16.2	23442
V-62	10.29	00:14	10.29	14:15	80-12.0E	01-01.9S	1.25	22.4	22300
V-63	10.29	14:22	10.30	02:01	80-29.4E	03-49.0S	1.05	20.5	24296
V-64	10.30	02:09	10.30	14:00	80-29.9E	06-23.6S	1.07	21.7	25238
V-65	10.30	14:05	10.31	02:02	80-31.1E	08-00.5S	1.08	21.0	24198
V-66	10.31	02:07	10.31	14:00	80-31.2E	08-00.8S	1.07	20.4	23726
V-67	10.31	14:04	11.1	02:00	80-31.0E	08-00.8S	1.07	20.0	23261
V-68	11.1	02:03	11.1	14:00	80-30.1E	08-00.7S	1.07	20.4	23726
V-69	11.1	14:04	11.2	02:00	80-30.6E	08-00.7S	1.07	20.5	23842
V-70	11.2	02:04	11.2	15:03	80-30.0E	07-59.9S	1.16	21.8	23387
V-71	11.2	15:06	11.3	02:00	80-30.7E	08-00.3S	0.98	18.0	22857
V-72	11.3	02:03	11.3	14:00	80-30.8E	07-59.9S	1.07	20.2	23493
V-73	11.3	14:05	11.4	02:00	80-31.2E	08-00.1S	1.07	20.2	23493
V-74	11.4	02:03	11.4	14:00	80-30.8E	08-00.6S	1.07	19.9	23144
V-75	11.4	14:03	11.5	02:00	80-30.9E	08-00.2S	1.07	21.8	25354
V-76	11.5	02:03	11.5	14:00	80-30.9E	07-59.9S	1.06	20.9	24537
V-77	11.5	14:03	11.6	02:00	80-30.9E	07-59.9S	1.07	21.0	24424
V-78	11.6	02:03	11.6	14:00	80-30.4E	07-59.8S	1.07	20.8	24191
V-79	11.6	14:03	11.7	02:00	80-30.5E	07-59.0S	1.07	20.4	23726
V-80	11.7	02:03	11.7	14:00	80-30.3E	07-59.9S	1.07	20.6	23958
V-81	11.7	14:03	11.8	02:00	80-30.7E	08-00.0S	1.07	21.8	25354
V-82	11.8	02:03	11.8	14:01	80-30.8E	07-59.7S	1.07	21.8	25354
V-83	11.8	14:05	11.9	02:00	80-30.7E	08-00.0S	1.07	20.6	23958
V-84	11.9	02:04	11.9	14:00	80-30.3E	08-00.7S	1.07	18.8	21865
V-85	11.9	14:03	11.10	02:01	80-30.1E	08-00.7S	1.07	19.8	23028
V-86	11.10	02:04	11.10	14:00	80-30.1E	08-00.2S	1.07	19.8	23028
V-87	11.10	14:03	11.11	02:00	80.30.8E	07-59.3S	1.07	19.8	23028
V-88	11.11	02:03	11.11	14:12	80.30.5E	07-59.7S	1.09	20.2	23062
V-89	11.11	14:15	11.12	02:00	80-30.7E	07-59.8S	1.05	19.8	23467
V-90	11.12	02:04	11.12	14:00	80-29.2E	08-01.0S	1.06	20.6	24184
V-91	11.12	14:04	11.13	02:00	80-30.0E	07-58.6S	1.07	20.8	24191
V-92	11.13	02:03	11.13	14:00	80-30.5E	07-58.8S	1.08	21.8	25119
V-93	11.13	14:04	11.14	02:00	80-30.1E	07-59.0S	1.08	21.0	24198
V-94	11.14	02:03	11.14	14:00	80-30.2E	07-59.9S	1.08	21.6	24889
V-95	11.14	14:03	11.15	02:00	80-30.9E	08-01.4S	1.07	21.4	24889
V-96	11.15	02:04	11.15	14:00	80-30.3E	08-00.3S	1.08	21.2	24428
V-97	11.15	14:03	11.16	02:00	80-30.6E	08-00.1S	1.07	21.8	25354
V-98	11.16	02:04	11.16	14:00	80-30.8E	07-59.4S	1.07	21.8	25354
V-99	11.16	14:03	11.17	02:01	80-30.5E	08-01.2S	1.07	21.6	25121
V-100	11.17	02:04	11.17	14:00	80-30.8E	08-00.4S	1.07	21.8	25354
V-101	11.17	14:03	11.18	02:00	80-30.7E	08-00.5S	1.07	22.0	25587
V-102	11.18	02:05	11.18	14:00	80-29.5E	08-00.1S	1.06	21.4	25124
V-103	11.18	14:03	11.19	02:00	80-29.6E	08-01.0S	1.07	22.0	25587
V-104	11.19	02:03	11.19	14:00	80-29.9E	07-59.5S	1.07	22.2	25819
V-105	11.19	14:03	11.20	02:00	80-30.7E	08-01.2S	1.07	21.0	24424

V-106	11.20	02:03	11.20	14:07	80-30.4E	08-00.3S	1.08	21.2	24428
V-107	11.20	14:10	11.21	02:00	80-31.2E	08-00.0S	1.06	20.2	23715
V-108	11.21	02:04	11.21	14:00	80-30.1E	08-00.1S	1.08	19.8	22815
V-109	11.21	14:03	11.22	02:00	80-30.5E	07-59.8S	1.08	20.8	23967
V-110	11.22	02:03	11.22	14:00	80-29.8E	08-01.0S	1.08	20.6	23737
V-111	11.22	14:04	11.23	02:00	80-30.6E	08-01.3S	1.07	20.0	23261
V-112	11.23	02:04	11.23	14:00	80-30.4E	08-00.7S	1.07	20.4	23726
V-113	11.23	14:08	11.24	02:00	80-30.7E	08-00.8S	1.07	21.8	25354
V-114	11.24	02:04	11.24	14:00	80-29.6E	08-00.7S	1.07	21.6	25121
V-115	11.24	14:02	11.25	02:00	80-28.7E	08-00.9S	1.07	21.2	24656
V-116	11.25	02:03	11.25	14:55	80-30.0E	07-59.9S	1.14	22.4	24452
V-117	11.25	14:58	11.26	02:00	80-30.9E	07-59.5S	0.98	19.8	25143
V-118	11.26	02:04	11.26	14:00	80-30.6E	08-00.1S	1.06	21.8	25593
V-119	11.26	14:02	11.27	02:02	80-30.4E	08-00.8S	1.07	21.6	25121
V-120	11.27	02:05	11.27	14:00	80-30.1E	08-00.1S	1.07	22.0	25587
V-121	11.27	14:02	11.28	02:00	80-30.2E	08-00.3S	1.08	23.0	26502
V-122	11.28	02:03	11.28	14:00	79-29.0E	06-48.3S	1.07	21.8	25354
V-123	11.28	14:02	11.29	02:15	78-06.0E	05-05.3S	1.09	23.6	26944
V-124	11.29	02:18	11.29	14:00	78-05.9E	05-04.9S	1.05	21.8	25837
V-125	11.29	14:03	11.30	02:00	79-04.0E	02-29.7S	1.07	21.4	24889
V-126	11.30	02:02	11.30	14:00	80-00.8E	00-00.3N	1.07	22.4	26052
V-127	11.30	14:01	12.1	02:00	80-28.2E	01-47.8N	1.09	21.6	24661

Table 5.27-2 Summary of precipitation sampling for isotope analysis.

	Date	**Time (UT)**	**Lon**	**Lat**	**Date**	**Time (UT)**	**Lon**	**Lat**	**Rain (mm)**	R/S
R-1	9.25	11:55	91-46.2E	04-04.2N	9.29	07:46	78-06.6E	05-06.6S	13.2	R
R-2	9.29	07:46	78-06.6E	05-06.6S	9.29	17:06	79-12.6E	06-26.8S	0.2	R
R-3	9.29	17:07	79-12.7E	06-26.9S	9.30	08:01	80-31.8E	07-59.2S	1.3	R
R-4	9.30	08:01	80-31.8E	07-59.2S	9/0	21:00	80.29.8E	08-00.0S	3.1	R
R-5	9.30	21:00	80-29.8E	08-00.0S	10.01	13:20	80-29.1E	08-00.0S	59.5	R
R-6	10.01	13:20	80-29.1E	07-59.5S	10.02	07:45	80-30.4E	08-00.2S	1.8	R
R-7	10.02	07:49	80-30.4E	08-00.2S	10.05	00:30	80-30.0E	07-59.8S	69.5	R
R-8	10.05	00:30	80-30.0E	07-59.8S	10.05	03:36	80-29.7E	07-59.7S	5.2	R
R-9	10.05	03:36	80-29.7E	07-59.7S	10.08	05:57	80-30.1E	08-00.0S	1.0	R
R-10	10.08	05:58	80-30.1E	08-00.0S	10.08	08:06	80-31.1E	07-59.8S	4.3	R
R-11	10.08	08:09	80-30.9E	07-59.9S	10.09	04:09	80-30.3E	07-59.8S	4.2	R
R-12	10.09	04:13	80-30.4E	07-59.8S	10.10	00:24	80-29.9E	07-59.8S	2.1	R
R-13	10.10	00:25	80-29.9E	07-59.8S	10.10	16:42	80-29.0E	08-01.3S	16.6	R
R-14	10.10	16:42	80-29.0E	08-01.3S	10.25	03:34	80-30.0E	02-57.0S	9.3	R
R-15	10.29	00:05	79-52.7E	02-13.8N	10.29	13:06	80-11.5E	00-44.5S	32.5	R
R-16	10.29	13:06	80-11.5E	00-44.5S	10.30	00:29	80-28.4E	03-26.4S	32.3	R
R-17	10.30	00:29	80-29.4E	03-26.4S	10.31	00:31	80-29.7E	07-59.9S	13.1	R
R-18	10.31	00:31	80-29.7E	07-54.9S	11.03	14:10	80-30.3E	07-59.6S	0.3	R
R-19	11.03	14:10	80-30.3E	07-59.6S	11.04	00:10	80-30.2E	07-59.8S	2.4	R
R-20	11.04	00:10	80-30.2E	07-59.8S	11.07	11:02	80-31.1E	08-00.3S	0.3	R
R-21	11.07	11:07	80-31.0E	08-00.2S	11.11	10:52	80-31.2E	07-59.6S	1.6	R
R-22	11.11	10:57	80-31.3E	07-59.3S	11.14	00:19	80-29.8E	07-59.9S	1.4	R
R-23	11.14	00:19	80-29.8E	07-59.9S	11.15	03:12	80-29.8E	07-59.8S	1.3	R
R-24	11.15	03:18	80-29.8E	07-59.8S	11.16	00:18	80-29.9E	08-00.1S	0.5	R
R-25	11.16	00:18	80-29.9E	08-00.1S	11.17	02:31	80-30.1E	08-00.1S	0.9	R
R-26	11.17	02:32	80-30.0E	08-00.1S	11.18	00:21	80-29.8E	08-00.1S	1.0	R
R-27	11.19	00:21	80-29.8E	08-00.1S	11.20	00:18	80-30.0E	08-00.2S	4.9	R
R-28	11.20	00:18	80-30.0E	08-00.2S	11.25	00:20	80-30.0E	08-00.2S	10.7	R
R-29	11.25	00:20	80-30.0E	08-00.2S	11.26	00:23	80-30.0E	07-59.9S	13.3	R
R-30	11.26	00:23	80-30.0E	07-59.9S	11.27	12:38	80-29.7E	07-59.8S	8.0	R
R-31	11.27	12:38	80-29.7E	07-59.8S	11.29	00:25	78-08.5E	05-08.9S	28.2	R
R-32	11.29	00:25	78-08.5E	05-08.9S	11.30	00:20	78-55.4E	02-52.8S	3.9	R

Table 5.27-3 Summary of sea surface water sampling for isotope analysis

Sampling No.		Date	Time (UTC)	Position LON	LAT
MR11-07 O-	1	9.26	06:05	88-22.0E	01-43.2E
MR11-07 O-	2	9.27	07:01	84-23.4E	01-12.6S
MR11-07 O-	3	9.28	07:04	80-38.9E	03-52.3S
MR11-07 O-	4	9.29	07:20	78-05.9E	05-05.3S
MR11-07 O-	5	9.30	07:23	80-30.7E	07-59.0S
MR11-07 O-	6	10.1	07:10	80-29.8E	07-59.4S
MR11-07 O-	7	10.2	07:00	80-30.1E	07-59.8S
MR11-07 O-	8	10.3	07:02	80-30.1E	08-00.2S
MR11-07 O-	9	10.4	06:59	80-30.4E	08-00.2S
MR11-07 O-	10	10.5	07:02	80-29.6E	07-59.9S
MR11-07 O-	11	10.6	07:05	80-29.7E	08-00.3S
MR11-07 O-	12	10.7	07:01	80-30.0E	08-00.2S
MR11-07 O-	13	10.8	07:03	80-30.2E	07-59.7S
MR11-07 O-	14	10.9	07:00	80-29.5E	08-00.0S
MR11-07 O-	15	10.10	07:00	80-29.7E	08-00.1S
MR11-07 O-	16	10.11	07:02	80-30.1E	07-59.9S
MR11-07 O-	17	10.12	07:00	80-29.9E	07-59.9S
MR11-07 O-	18	10.13	16:39	80-29.7E	08-00.6S
MR11-07 O-	19	10.14	07:00	80-29.7E	08-00.1S
MR11-07 O-	20	10.15	07:30	80-30.6E	08-00.1S
MR11-07 O-	21	10.16	07:00	80-29.9E	07-59.9S
MR11-07 O-	22	10.17	07:00	80-29.9E	08-00.1S
MR11-07 O-	23	10.18	07:20	80-30.1E	08-00.3S
MR11-07 O-	24	10.19	07:03	80-29.7E	08-00.0S
MR11-07 O-	25	10.20	07:02	80-31.8E	07-59.7S
MR11-07 O-	26	10.21	07:00	80-30.7E	07-59.8S
MR11-07 O-	27	10.22	07:00	80-29.8E	07-59.8S
MR11-07 O-	28	10.23	07:00	80-29.9E	07-59.9S
MR11-07 O-	29	10.24	07:00	80-29.7E	07-58.4S
MR11-07 O-	30	10.25	07:01	80-30.0E	02-07.0N
MR11-07 O-	31	10.29	07:00	80-01.3E	00-40.7N
MR11-07 O-	32	10.30	07:00	80-30.0E	04-50.2S
MR11-07 O-	33	10.31	07:00	80-29.9E	08-00.0S
MR11-07 O-	34	11.1	07:02	80-29.9E	07-59.7S
MR11-07 O-	35	11.2	07:00	80-29.9E	07-59.8S
MR11-07 O-	36	11.3	07:00	80-29.9E	08-00.0S
MR11-07 O-	37	11.4	07:00	80-30.0E	07-59.8S
MR11-07 O-	38	11.5	07:00	80-30.2E	07-59.6S
MR11-07 O-	39	11.6	07:00	80-30.0E	07-59.8S
MR11-07 O-	40	11.7	07:00	80-30.0E	07-59.8S
MR11-07 O-	41	11.8	07:00	80-29.8E	07-59.8S
MR11-07 O-	42	11.9	07:00	80-29.8E	07-59.8S
MR11-07 O-	43	11.10	07:00	80-29.7E	07-59.8S
MR11-07 O-	44	11.11	07:03	80-29.6E	07-59.8S
MR11-07 O-	45	11.12	07:00	80-29.4E	08-00.0S
MR11-07 O-	46	11.13	07:00	80-29.7E	07-59.7S
MR11-07 O-	47	11.14	07:00	80-29.5E	07-59.7S
MR11-07 O-	48	11.15	07:00	80-29.7E	08-00.2S
MR11-07 O-	49	11.16	07:00	80-29.5E	07-59.8S
MR11-07 O-	50	11.17	07:01	80-29.8E	08-00.1S
MR11-07 O-	51	11.18	07:00	80-29.2E	08-00.0S
MR11-07 O-	52	11.19	07:00	80-29.5E	08-00.3S
MR11-07 O-	53	11.20	07:00	80-30.1E	07-59.9S
MR11-07 O-	54	11.21	07:00	80-29.7E	07-59.6S
MR11-07 O-	55	11.22	07:01	80-29.7E	07-59.8S
MR11-07 O-	56	11.23	07:01	80-29.7E	07-59.9S
MR11-07 O-	57	11.24	07:00	80-29.8E	07-59.8S
MR11-07 O-	58	11.25	07:00	80-29.7E	07-59.9S
MR11-07 O-	59	11.26	07:00	80-29.6E	08-00.0S
MR11-07 O-	60	11.27	07:00	80-29.8E	08-00.0S
MR11-07 O-	61	11.28	07:00	80-29.4E	08-00.0S
MR11-07 O-	62	11.29	07:00	78-06.1E	05-07.7S
MR11-07 O-	63	11.30	07:00	79-30.3E	01-19.8S

5.28 Underway geophysics

5.28.1 Sea surface gravity

(1) Personnel (*: Leg-1, **: Leg-2, ***: Leg-1+2)

Takeshi MATSUMOTO	(University of the Ryukyus)	- Principal Investigator (not on-board)
Souichiro SUEYOSHI***	(GODI)	- Operation Leader (Leg-1 and 2)
Asuka DOI***	(GODI)	
Toshimitsu GOTO***	(GODI)	
Katsuaki MAENO *	(GODI)	
Ryo KIMURA*	(GODI)	
Satoshi OKUMURA**	(GODI)	
Kazuho YOSHIDA**	(GODI)	
Wataru TOKUNAGA***	(MIRAI Crew)	

(2) Introduction

The local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface.

(3) Parameters

Relative Gravity [CU: Counter Unit]

[mGal] = (coef1: 0.9946) * [CU]

(4) Data Acquisition

We measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (Micro-G LaCoste, LLC) during the MR11-07 cruise from 25th September to 1st December 2011.

To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter (CG-5, Scintrex), at Sekinehama before departure, and will measure after MR11-08, as the reference point.

(5) Preliminary Results

Absolute gravity will be calculated on February 2012, going back to Sekinehama port.

(6) Data Archives

Surface gravity data obtained during this cruise will be submitted to the Data Management Group (DMG) of JAMSTEC, and will be archived there.

(7) Remarks (Times in UTC)

1) The observation was carried out within following periods,
   Leg1: 12:00 25th Sep. 2011 to 23:59 25th Oct. 2011.
   Leg2: 00:00 29th Oct. 2011 to 03:00 1st Dec. 2011.

2) Spring tension value jumped by about 350CU due to sensor trouble on 16th November.

5.28.2 Sea surface three-component magnetometer

(1) Personnel

Takeshi MATSUMOTO	(University of the Ryukyus)	*Principal Investigator (not on-board)
Souichiro SUEYOSHI	(GODI)	*Operation Leader (Leg-1 and 2)
Asuka DOI	(GODI)	
Toshimitsu GOTO	(GODI)	
Katsuaki MAENO	(GODI)	
Ryo KIMURA	(GODI)	
Satoshi OKUMURA	(GODI)	
Kazuho YOSHIDA	(GODI)	
Wataru TOKUNAGA	(MIRAI Crew)	

(2) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR11-07 cruise from 25th September 2011 to 1st December 2011.

(3) Principle of ship-board geomagnetic vector measurement

The relation between a magnetic-field vector observed on-board, **H**ob, (in the ship's fixed coordinate system) and the geomagnetic field vector, **F**, (in the Earth's fixed coordinate system) is expressed as:

$$\mathbf{H}ob = \widetilde{\mathbf{A}}\ \widetilde{\mathbf{R}}\ \widetilde{\mathbf{P}}\ \widetilde{\mathbf{Y}}\ \mathbf{F} + \mathbf{H}p \qquad \text{(a)}$$

where $\widetilde{\mathbf{R}}$, $\widetilde{\mathbf{P}}$ and $\widetilde{\mathbf{Y}}$ are the matrices of rotation due to roll, pitch and heading of a ship, respectively. $\widetilde{\mathbf{A}}$ is a 3 x 3 matrix which represents magnetic susceptibility of the ship, and **H**p is a magnetic field vector produced by a permanent magnetic moment of the ship's body. Rearrangement of Eq. (a) makes

$$\widetilde{\mathbf{B}}\ \mathbf{H}ob + \mathbf{H}bp = \widetilde{\mathbf{R}}\ \widetilde{\mathbf{P}}\ \widetilde{\mathbf{Y}}\ \mathbf{F} \qquad \text{(b)}$$

where $\widetilde{\mathbf{B}} = \widetilde{\mathbf{A}}^{-1}$, and $\mathbf{H}bp = -\widetilde{\mathbf{B}}\mathbf{H}p$. The magnetic field, **F**, can be obtained by measuring $\widetilde{\mathbf{R}}$, $\widetilde{\mathbf{P}}$, $\widetilde{\mathbf{Y}}$ and **H**ob , if $\widetilde{\mathbf{B}}$ and **H**bp are known. Twelve constants in $\widetilde{\mathbf{B}}$ and **H**bp can be determined by measuring variation of **H**ob with $\widetilde{\mathbf{R}}$, $\widetilde{\mathbf{P}}$ and $\widetilde{\mathbf{Y}}$ at a place where the geomagnetic field, **F**, is known.

(4) Instruments on R/V MIRAI

A shipboard three-component magnetometer system (Tierra Tecnica SFG1214) is equipped on-board R/V MIRAI. Three-axes flux-gate sensors with ring-cored coils are fixed on the fore mast. Outputs from the sensors are digitized by a 20-bit A/D converter (1 nT/LSB), and sampled at 8 times per second. Ship's heading, pitch, and roll are measured by the Inertial Navigation System (INS) for controlling attitude of a Doppler radar. Ship's position (GPS) and speed data are taken from LAN every second.

(5) Data Archives

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC.

(6) Remarks (Times in UTC)

1) The observation was carried out within following periods,
   Leg1: 12:00 25th Sep. 2011 to 23:59 25th Oct. 2011.
   Leg2: 00:00 29th Oct. 2011 to 03:00 1st Dec. 2011.
2) For calibration of the ship's magnetic effect, we made a "figure-eight" turn (a pair of clockwise and anti-clockwise rotation). This calibration was carried out as below.
   01:32 29th Sep. 2011 to 01:59 29th Sep. 2011 (05-08S, 78-23E)
   21:58 30th Oct. 2011 to 22:22 30th Oct. 2011 (08-00S, 80-30E)

5.28.3 Swath Bathymetry

(1) Personnel

Takeshi MATSUMOTO	(University of the Ryukyus)	*Principal Investigator (not on-board)
Souichiro SUEYOSHI	(GODI)	*Operation Leader (Leg-1 and 2)
Asuka DOI	(GODI)	
Toshimitsu GOTO	(GODI)	
Katsuaki MAENO	(GODI)	
Ryo KIMURA	(GODI)	
Satoshi OKUMURA	(GODI)	
Kazuho YOSHIDA	(GODI)	
Wataru TOKUNAGA	(MIRAI Crew)	

(2) Introduction

R/V MIRAI equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 2112 (SeaBeam Instruments Inc.). The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets.

(3) Data Acquisition

The "SEABEAM 2112" on R/V MIRAI was used for bathymetry mapping during the MR11-07 cruise from 25th September to 1st December 2011.

To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data to get the sea surface (6.2m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD or XCTD or ARGO data by the equation in Del Grosso (1974) during the cruise.

Table 5.28.3-1 shows system configuration and performance of SEABEAM 2112.004 system.

Table 5.28.3-1 System configuration and performance

SEABEAM 2112 (12 kHz 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) Preliminary Results

The results will be published after primary processing.

(5) Data Archives

Bathymetric data obtained during this cruise will be submitted to the Data Management Group of JAMSTEC, and will be archived there.

(6) Remarks (Times in UTC)

The observation was carried out within following periods,

Leg1: 12:05 25th Sep. 2011 to 11:12 30th Sep. 2011
06:35 24th Sep. 2011 to 00:07 26th Oct. 2011

Leg2: 23:59 28th Oct. 2011 to 22:19 30th Oct. 2011
07:24 28th Nov. 2011 to 03:00 1st Dec. 2011