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 Intreseasonal Variability in the Indian Ocean
(as a component of project “CINDY”
[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.