Cruise Summary

1. Ship name and Cruise code

R/V MIRAI

MR10-03

2. Title of the Cruise (Main Mission)

Observational Study on Air-Sea Interaction in the Tropical Western Pacific Ocean

3. Chief Scientist

Hiroyuki Yamada

Tropical Climate Variability Research Program,

Research Institute for Global Change, JAMSTEC

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

(1) Maritime aerosol optical properties from measurements of Ship-borne sky radiometer

PI: Kazuma Aoki (Toyama University)

(2) Relationship between the generation of tropical cyclones by merging precipitating systems and the variability of the tropical atmosphere

PI: Tetsuya Takemi (Kyoto University)

(3) On-board continuous air-sea eddy flux measurement

PI: Osamu Tsukamoto (Okayama University)

(4) Study of ocean circulation and heat and freshwater transport and their variability, and experimental comprehensive study of physical, chemical, and biochemical processes in the western North Pacific by the deployment of Argo floats and using Argo data

PI: Toshio Suga (JAMSTEC / Tohoku University)

(5) Dynamics of nutrients and associated biological productivity in the oligotrophic subtropical ocean

PI: Ken Furuya (The University of Tokyo)

(6) Distribution and ecology of oceanic *Halobates* inhabiting western tropical area in the pacific ocean and their responding system to several environmental factors.

PI: Tetsuo Harada (Kochi University)

(7) Water sampling for building water isotopologue map over the Ocean

PI: Naoyuki Kurita (JAMSTEC)

(8) Lidar observations of optical characteristics and vertical distribution of aerosols and clouds

PI: Nobuo Sugimoto (National Institute for Environmental Studies)

(9) Structure of precipitation systems and their interaction to the atmospheric environment over the tropical western Pacific Ocean

PI: Taro Shinoda (Nagoya University)

(10) Standardising the marine geophysics data and its application to the ocean floor geodynamics studies

PI: Takeshi Matsumoto (University of the Ryukyus)

(11) Distribution and Configuration of Clouds in Various Oceans

PI: Toshiaki Takano (Chiba University)

5. Period and Ports of call

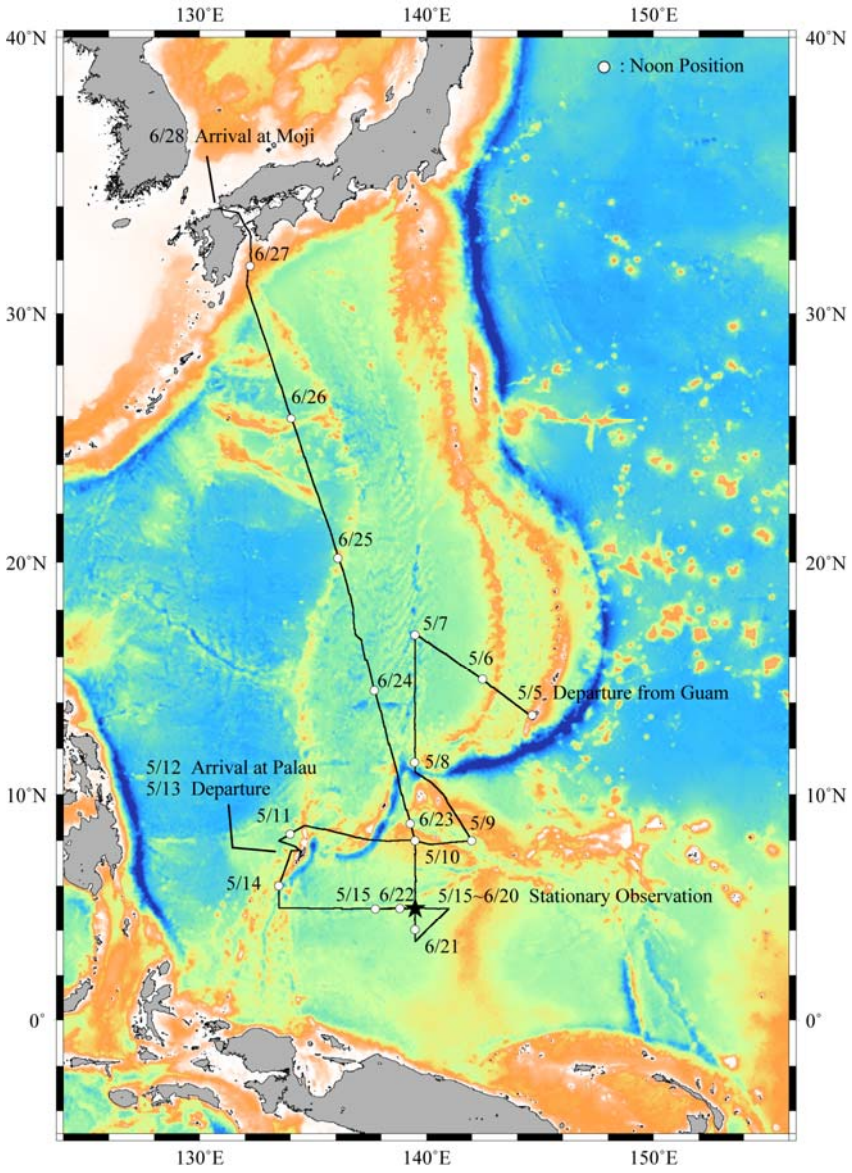
2010	May 05	departed Guam, United States
	May 12-13	called at Koror, Republic of Palau
	June 28	arrived at Moji, Japan

6. Research Area

Tropical Western Pacific Ocean

Stationary observation at fixed site at 5N, 139.5E from 16 May through 22 June 2010 (38 days)

MR10-03 Cruise Track



7. Purpose

It is known that cumulus clouds frequently develop over a warm water pool in the tropical western Pacific Ocean in summer. These clouds sometimes organize a convective cloud system with the horizontal dimension of several hundred kilometers, and some of them occasionally develop into a tropical depression and cyclone. A huge amount of heat released from these systems drives a large-scale atmospheric circulation. However, the mechanism governing the development of these cloud systems has not been understood yet. In particular, the relationship between the cloud systems and large-scale atmospheric disturbances, such as a Madden-Julian Oscillation (MJO), and/or an intra-seasonal variability (ISV) during an Asian summer monsoon season, is still unclear. Moreover, a role of the warm pool on the development of clouds and atmospheric disturbances is not clarified yet. Therefore, the aim of this cruise was to examine the processes of interaction between atmospheric convection and oceanic mixed layer in the tropical western Pacific.

8. Overview of Observations

In order to investigate the atmospheric and oceanic conditions, the intensive observations were carried out. First, we deployed 7 Argo floats within an area between 133.5 and 142.5^{o}E and between 6 and 17^{o}N. Then, we conducted the observations at a fixed site at 5.0^{o}N, 139.5^{o}E from May 16 through June 22 (38 days).

Although winds in the lower troposphere were mostly easterly throughout the observation period, significant changes in the convective activity and ocean structure were observed at the fixed point. During the first half month of observation period, convective activity was continuously high due to the development of convective clouds over the intertropical convergence zone (ITCZ). In the following half month, convective activity varied periodically in a 4-5 day cycle. This change related to the passage of equatorial waves/disturbances during a convectively inactive phase before the onset of Asian summer monsoon. In the remaining period, deep convective cloud systems much developed due to the eastward propagation of an intra-seasonal variation (ISV) from the Indian Ocean to the western Pacific. At the same time, the northward propagation of a convectively-active area was also significant in the western Pacific. These changes in the convective activity in the observational area can be confirmed by the time series of Doppler radar echo area (see Fig. 1). The GPS radiosonde observation captured a negative anomaly of temperature in the upper troposphere during the convectively active period, which suggests the predominance of large-scale upward motion associated with the ISV.

Changes in the structure of the oceanic surface layer, related with the atmospheric variation, were observed by CTDO profiling and Argo-float observations. A warming of surface mixed layer in May, followed by cooling in June, can be seen in Fig. 2. The CTD data also show a significant change in salinity in a sub-surface layer (100-200m depth) at the fixed point, which suggests an intrusion of water with high salinity from the south.

These features suggest that the changes in the atmospheric and oceanographic conditions, associated with ISV in a boreal summer over the tropical western Pacific, were successfully captured by the observation at the fixed point. During the cruise, the following observations were intensively conducted.

(1) GPS Radiosonde	360 times	from May 6 to June 27
(2) 5.3-GHz Doppler radar	continuously	from May 6 to June 26
(3) 95-GHz cloud profiling radar	continuously	from May 6 to June 27
(4) Mie-scattering LIDAR	continuously	from May 6 to June 27
(5) Ceilometer	continuously	from May 5 to June 27
(6) GPS Meteorology	continuously	from May 5 to June 27
(7) Infrared radiometer	continuously	from May 6 to June 27

(8) Sky Radiometer	continuously	from May 6 to June 27
(9) Rain and water vapor sampling	continuously	from May 5 to June 27
(10) Surface Meteorology	continuously	from May 5 to June 27
(11) Atmospheric turbulent flux	continuously	from May 6 to June 27
(12) Sea surface water monitoring	continuously	from May 6 to June 27
(13) CTDO profiling	304 times	from May 6 to June 22
(14) Sea water sampling	36 times	from May 16 to June 22
(15) Photosynthetically active radiation	18 times	from May 16 to June 19
(16) Argo float deployment	7 times	from May 05 to May 13
(17) Oceanic microstructure profiling	118 times	from May 06 to June 20
(18) Shipboard ADCP	continuously	from May 6 to June 27
(19) Gravity/Magnetic force	continuously	from May 5 to June 27
(20) Topography	continuously	from May 5 to June 27
(21) Sea skater sampling	30 times	from May 16 to June 20

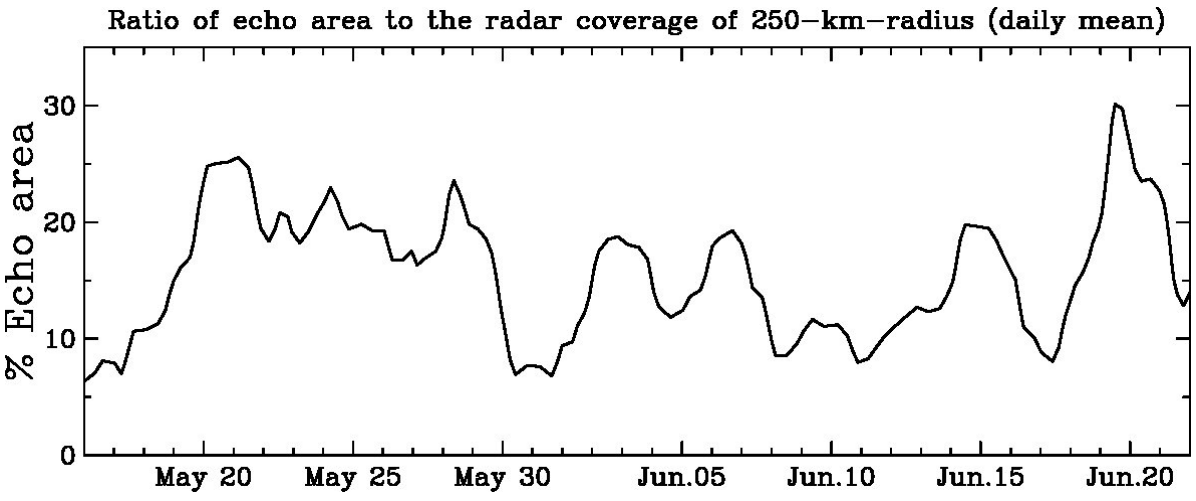


Fig. 1 *Variation of radar echo areas obtained from surveillance PPI scans. The indicated value is the ratio of the echo area to the radar coverage area with a radius of 250 km.*

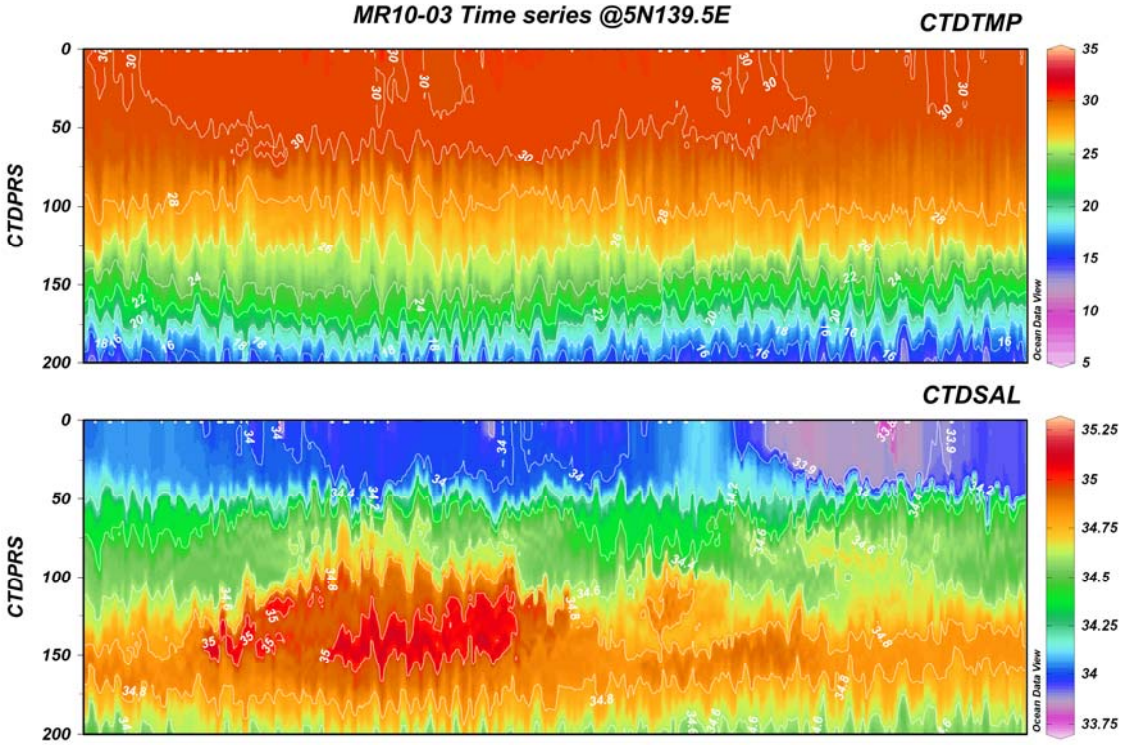


Fig. 2. *Time-pressure cross section of ocean temperature and salinity between 0 and 200 dbar, observed at the fixed point (5°N, 139.5°E) from 16 May through 22 June.*