MR02-K04 Cruise Summary

1. Cruise name and code

Tropical Ocean Climate Study
MR02-K04 (Leg 1 and Leg 2)

2. Introduction and observation summary

2.1. Introduction

This cruise has two major purposes. One is to observe physical oceanographic conditions in the western tropical Pacific Ocean for better understanding of air-sea interaction affecting on the ENSO (El Nino/Southern Oscillation) phenomena and its related climate change. The surface layer in the western tropical Pacific Ocean is characterized by high sea surface temperature, which plays major role in driving global atmospheric circulation. El Nino occurs when warm water migrates eastward, and causes short-term climate changes in the world dramatically. For example, the western Pacific area has very little rainfall when the "El Nino" occurred, as in 1997-98. This atmospheric and oceanic system is so complicated, and we still do not have enough knowledge about it.

The other purpose is to observe hydrographic conditions and its variability in the eastern tropical Indian Ocean associated with Asian Monsoon and Dipole Mode variability. Asian Monsoon may play an important role as a trigger of El Nino in the Pacific Ocean. Also the Indian Ocean has basin-scale interannual variability independent to ENSO mentioned as Dipole Mode variability. This climate system has various time scales. To investigate the mechanism, we need precise and detailed data for long period. Therefore, ocean and atmosphere observing mooring array is effective to obtain such data set. The major mission of this cruise is to deploy TRITON buoys developed at JAMSTEC for the long term measurements of ocean and atmosphere in the western tropical Pacific Ocean and the eastern Indian Ocean. We also deployed ADCP subsurface buoys in the Pacific and the Indian Oceans during this cruise.

The other purposes of this cruise are,

1. Currents, temperature and salinity measurement using a subsurface ADCP mooring and ARGO floats by Frontier Observational Research System for Global Change (FORSGC).
2. Optical measurement of properties of atmospheric aerosols by particle counter and sky radiometer by Hokkaido University.
3. Lidar backscatter measurements of lower atmosphere by National Institute for Environmental Studies (NIES) of Japan.
4. Measurement of precipitating convective system in the Indian Ocean using Doppler radar and rawinsonde by FORSGC.

2.2. Overview

Observed oceanic and atmospheric conditions

ENSO status from TAO/TRITON buoy data:

The TRITON and TAO (Tropical Atmosphere and Ocean) buoy data along the equator in the Pacific Ocean indicates development of El Nino in 2002. The warm water pool in the western tropical Pacific Ocean had stored enough heat for causing next El Nino during the La Nina years of 1998-2000. The condition for the onset of El Nino is to have a series of westerly wind bursts associated with intraseasonal atmospheric disturbance over the western tropical Pacific Ocean that pushes the warm water from west to east. Major events of westerly wind bursts were observed in June- July and November-December 2001. After these events, the warm water anomaly reached the Pacific eastern boundary and raised the sea surface temperature (SST) in the eastern Pacific. The monthly sea surface temperature from TRITON and TAO mooring array in June 2002 indicated that 1 deg-C positive anomaly was widely spread from 170E to 100W. By this warming in the entire equatorial Pacific Ocean, Japan Meteorological Agency and National Centers for Environmental Prediction in USA announced in July 2002 that an El Nino has been developing. The relatively low warming level compare to 1997/1998 indicates the developing El Nino to be moderate.

Leg 1: Observation in the western tropical Pacific

During the Leg 1 period, the four typhoons were born and hit Japan. This may be due to the Pacific high-pressure system migrated eastward associated with the El Nino development. By the typhoon RAMMASUN passing through west of the ship course, we encountered strong winds (30 m/s) and high waves (6-8 m) during June 30 - July 1 and delayed one day, otherwise another three typhoons (CHATAAN, HALONG, NAKRI) passed north of the ship and less affected to the observational works.

SST in the western tropical Pacific Ocean on the ship course was almost normal. Along the 130E section, strong SSE winds associated with southwesterly monsoon and the typhoons dominated. By this enhanced southwesterly monsoon, the Halmahera eddy was strongly enhanced, and at the 2N130E near Halmahera Island the high salinity core water over 35.4 psu distributed thickly from 160-230 m depth, which may be transported by the direct inflow of the enhanced northward flowing New Guinea Coastal Current and its Under Current into the Halmahera eddy. The surface layer of the Mindanao Current is also strengthened up to 2.0 m/s during this cruise compare to 1 m/s during the previous cruise of October 2001 based on the shipboard ADCP and moored ADCP data. The current at the TRITON site of 5N130E is also strong as 1.5 m/s due to the enhanced Mindanao Current and Halmahera Eddy.

During the previous cruise of October 2001, the Mindanao Current was extended to southward and low salinity North Pacific Tropical Water was dominated in the Halmahera region. Thus the results indicate how the water masses in the region can vary with the Pacific low latitude western boundary currents in the seasonal and El Nino time scales. The water mass change is important to investigate the heat and salt transport process in the warm pool region and understand the slowly varying ocean conditions in the process of El Nino development.

Leg 2: Observation in the eastern Indian Ocean

July/August is in summer monsoon season in the Indian Ocean. The climatology indicates that southwesterly winds dominate in the northern hemisphere, and wind curl is anticyclonic north of about 15S. Upper ocean layer current is forced by these wind fields, current is expected to flow eastward north of equator and westward south of equator, respectively. However, the observed current was different from climatological seasonal pattern. Strong westward currents were observed in the northern hemisphere along 90E. SST (at 5 m depth) in the northern hemisphere along 90E is warmer as 29.3-29.8 deg-C than in the southern hemisphere, and water masses less than 34 psu was observed north of Sumatra Island, indicating the low saline water from the Bay of Bengal.

Two TRITON buoys and one ADCP mooring were recovered/re-deployed in the eastern Indian Ocean, and deployed four Argo floats successfully. We also carried out CTD and shipboard ADCP measurements without significant problem.
During the way back to Japan steaming in the Pacific, one typhoon (PHANFONE) was born and hit our ship course. Due to the severe oceanic condition associated with the typhoon, R/V Mirai arrived on 21 August with one-day delay at the port of Hachinohe.

2.3 Observation summary

TRITON buoy deployment:	9 sites
TRITON buoy recovery:	7 sites
ADCP subsurface buoy deployment:	2 sites
ADCP subsurface buoy recovery:	2 sites
CTD (Salinity, Temperature, Depth):	28 casts down to 1000 or 2000m
XCTD (Salinity, Temperature, Depth):	114 times down to 1000m
Surface meteorology:	continuous
ADCP measurements:	continuous
Surface temperature, salinity measurements by intake method:	continuous
Atmospheric aerosols measurement by particle counter and sky radiometer:	continuous
Lidar backscatter measurement:	continuous
Doppler radar measurement:	continuous (during Leg 2)
Rawinsonde measurement:	62 launches (during Leg 2)
Profiling floats (ARGO float) deployment:	6 launches
Underway-geophysical measurements:	continuous

3. Period and port of call

Leg1: June 25, 2002 (Sekinehama, Japan)-July 23, 2002 (Port Kelang, Malaysia)
Leg2: July 25, 2002 (Port Kelang, Malaysia)-August 22, 2002 (Sekinehama, Japan)

4. Chief scientist

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5. Research participants

Total 30 scientists and technical stuff participated from 10 different institutions, universities and companies including 6 foreign scientists and officers from Indonesia, Malaysia and USA.

JAMSTEC	Y. Kuroda and H. Hase
FORSGC	S. Mori and H. Matsuura
NIES	I. Matsui and A. Shimizu
Hokkaido Univ.	Y. Fujitani
Indonesian Navy	Mekky Mukarrom Santoso
Indonesia	Agus Saleh Atmadipoera and Albertus Sulaiman
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MWJ	M. Fujisaki, T. Matsumoto, H. Matsunaga, M. Taguchi, K. Shiraishi, T. Takamori, K. Suminaga, Y. Sonoyama, M. Yoshiike, H. Muramatsu, T. Suzuki, M. Nishino and A. Ito
GODI	M. Hanyu, Y. Imai, W. Tokunaga, and S. Iwamida