MR00-K02 Cruise Summary

1. Cruise name and code

Tropical Ocean Climate Study
MR00-K02
Ship: R/V Mirai
Captain: Masaharu Akamine (total 35 crew members)

2. Introduction and observation summary

2.1 Introduction

The purpose of this cruise is to observe physical oceanographic conditions in the western tropical Pacific Ocean to achieve a 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. Especially, El Nino occurs when warm water migrates eastward, and causes climate changes in the world dramatically. For example, the western Pacific area has very less rainfall when the "El Nino" occurred, as in 1997-98, and much rainfall during La Nina as in 1999-2000. This atmospheric and oceanic system is so complicated, and we still do not have enough knowledge about it. This climate system related ENSO has about 4-year time scale. To investigate the mechanism, we need precise and detailed data for the long period continuously. Therefore, ocean and atmosphere observing mooring array is effective to obtain such data set. The major mission of this cruise is to maintain TRITON buoys developed at JAMSTEC for the long term measurements of ocean and atmosphere in the western tropical Pacific Ocean. We have successfully recovered and deployed at 6 TRITON buoys sites along 156E during this cruise and will continue the measurements. We also recovered, deployed and repaired the TAO-ATLAS buoys along 165E, which are maintained by Pacific Marine Environmental Laboratory/NOAA/USA. The TAO-ATLAS buoys west of 156E have been replaced by TRITON buoys since November 1999, and the TRITON array have been contributing basin wide ENSO monitoring in the tropical Pacific Ocean harmonized with TAO array.

2.2 Overview

This MR00-K02 cruise has been carried out under the matured La Nina condition after sudden decay of historical 1997-1998 El Nino event in May 1998. Along the 165E section, easterly trade wind around 10 m/s was dominant. Swell was 2-3 m high due to prevailed trade winds and developed northern north Pacific Low. Intraseasonal atmospheric disturbance hit our cruise track and caused active convection and heavy rain north of 2N. Large scale cloud system frequently popped up over the tropical ocean of 3N-10N and 130E-160E, and along the South Pacific Convergence Zone from Papua New Guinea to Solomon Islands from GMS images.
Oceanic conditions along 165E and 156E are summarized as below. Along the 165E, high sea surface temperature over 29 deg-C was observed both hemispheres 5N-6N and 2S-

5S, and relatively low at the equator as 27 deg-C. Low sea surface salinity (SSS) about 34 psu was observed at 5N-7N, it indicates that there was local heavy rainfall and/or fresh water advection from west by the North Pacific Counter Current. On the contrary at 2S-5S, high salinity over 35.5 psu was observed. The 165E CTD/XCTD section shows that the surface warm water over 28 deg-C reached 130 m depth south of 3S, however, the surface water on the equator is relatively cool as 27 deg-C down to 125 m because of equatorial upwelling as same as SST. The 20 deg-C isotherm depth at the equator is 180 m and it is quite deep. The surface layer shows high salinity as 35.2 psu south of 2N, and 35.5 psu south of 3S and it may be caused by westward advection of saline water by the South Equatorial Current, which we observed as 1.7 kt from the eastern Pacific.

Along the 156E, relatively low SSS as 34.5 psu compare to surrounded high saline water as 35.5 psu observed at 5S which is caused by local rain fall at northern edge of the South Pacific Convergence Zone. The surface low salinity layer may cause the high SST over 30 deg-C at 5S, 156E by the mechanism of barrier layer with shallow halocline. High SSS water was also observed 2S-5S and gradually decrease toward the north. At the equator, SST was relatively cool as 28 deg-C which is still caused by equatorial upwelling by prevailed easterly trade winds, and SSS was still high as about 35 psu which was brought by the westward South Equatorial Current driven by easterly winds. The CTD/XCTD section along 156E shows that freshened surface mixing layer of 34.8 psu at 5S and high temperature 30 deg-C. Salinity in the surface layer decreased toward the North and became lowest as 33.8 psu at 8N. Warm waters over 29 deg-C were accumulated well south of 3S and 4N-5N. At the equator temperature was little bit cool as 28 deg-C by equatorial upwelling. The 20 deg-C isotherm depth was still deep as 200m. Surface westward current at the equator was strong as well as 165E.

Time series data of TRITON buoy demonstrated matured La Nina condition that heat has been accumulated enough to cause next El Nino in the western Pacific Ocean. 20 deg-C isotherm in the thermocline layer is an index of heat storage and deep isotherm indicates warm water accumulation in the surface layer. Figure 2-1 shows the time series of monthly mean 20 deg-C isotherm depth and its anomalies along the equator obtained from TAO/TRITON. This shows the 160 m contour of 20 deg-C isotherm line disappeared and became much shallow in the western tropical Pacific Ocean during 1997/1998 El Nino, and 120 m contour intrude into the eastern Pacific Ocean. It means that the warm water in the western Pacific immigrated to the eastern Pacific. Important thing is that the 20 deg-C isotherm depth is over 180 m and the anomalies is over 10 m in February 2000 as same as February 1996 in the western Pacific. Furthermore, the 20 deg-C isotherm depth along 156E (Figure 2-2) indicated that the 160 m contour extended north of 5N and the anomalies over 10 m developed at the latitude. Thus, heat has been well accumulated more widely than that before 1997/1998 El Nino event in the western tropical Pacific. One different condition is that the zonal winds along the equator show easterly winds prevailed as observed during this cruise and negative anomalies, however, early 1996 or 1997 the westerly winds were prevailed and large positive anomalies existed west of 156E (Figure 2-3). In terms of ENSO onset, we should watch the westerly winds appearance and eastward shift of 20 deg-C isotherm depths.

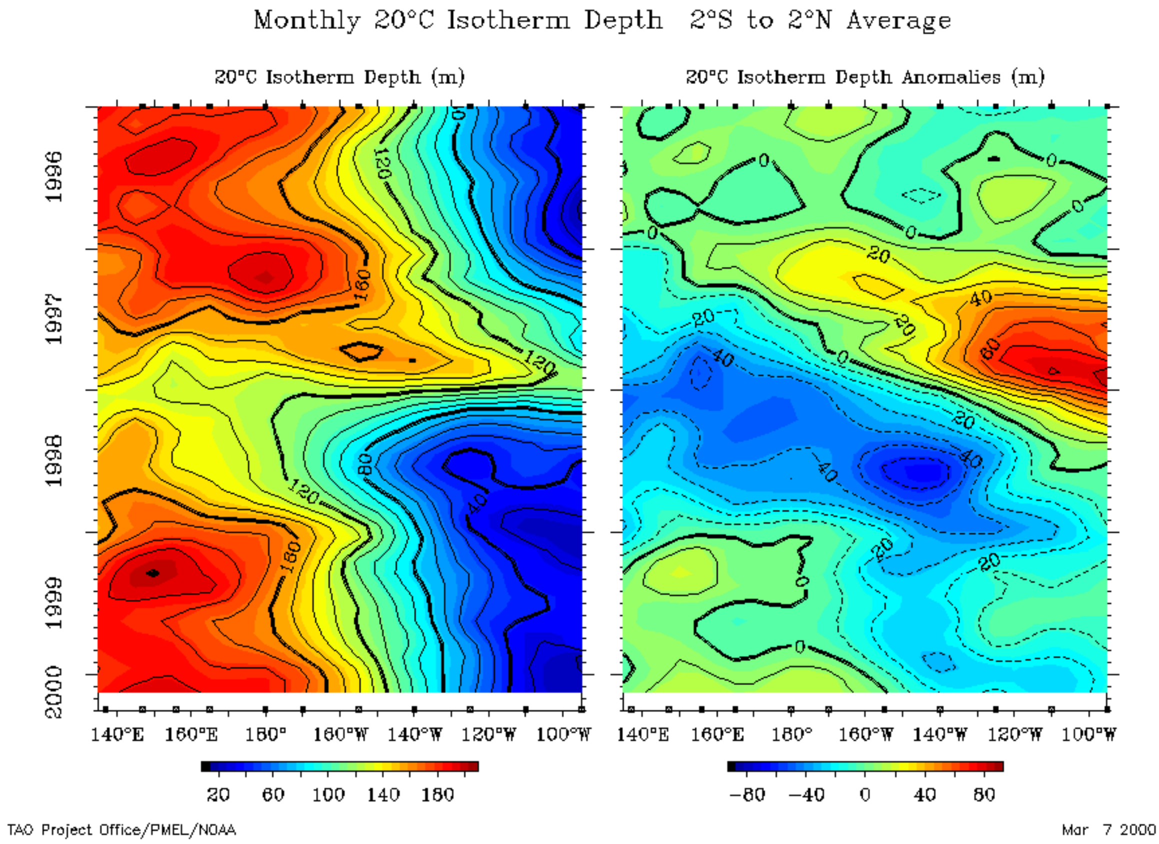

Figure 2-1. Time-longitude sections of monthly 20 deg-C isotherm depth (left) and its anomaly (right) between 2N and 2S observed by TAO/TRITON buoys. (Period: Jan. 1996 - Feb. 2000)

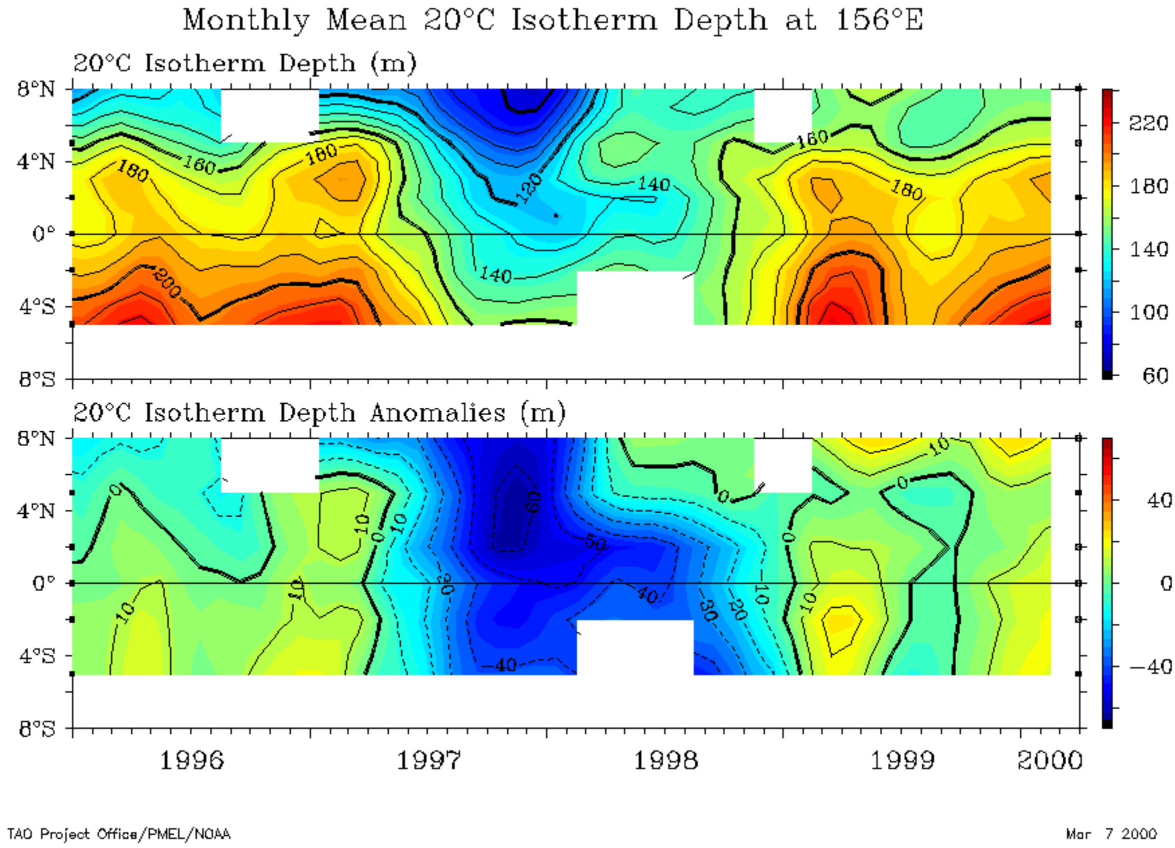

Figure 2-2. Time-latitude sections of monthly 20 deg-C isothem depth (upper) and its anomaly (lower) along 156E observed by TAO/TRITON buoys. (Period: Jan. 1996 - Feb. 2000)

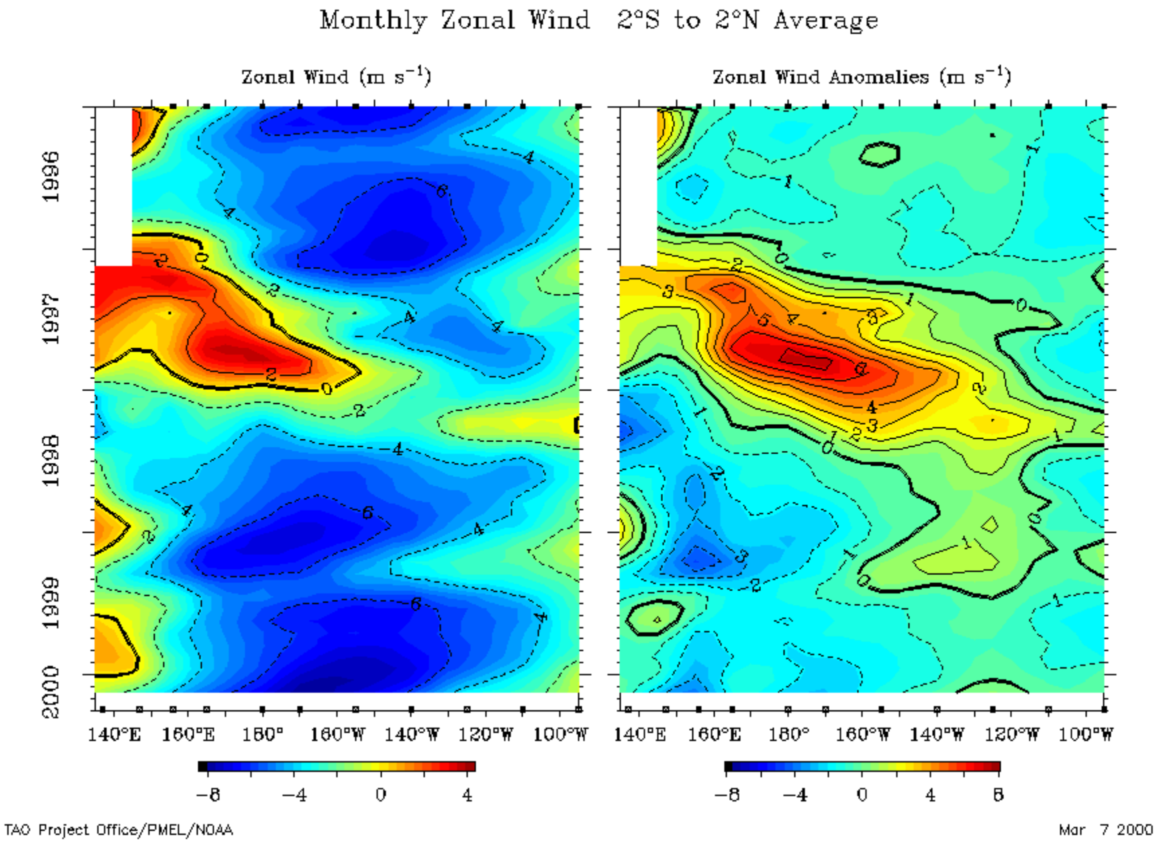

Figure 2-3. Time-longitude sections of monthly zonal wind between 2N and 2S (left) and its anomaly (right) observed by TAO/TRITON buoys. (Period: Jan. 1996 – Feb. 2000)

2.3 Observation summary

TRITON buoy deployment:	6 sites
TRITON buoy recovery:	6 sites
Subsurface ADCP buoy deployment:	1 site
Subsurface ADCP buoy recovery:	1 site
ATLAS buoy deployment:	3 site
ATLAS buoy recovery:	2 sites
ATLAS buoy repair:	2 sites
Subsurface current meter mooring recovery:	7 sites
CTD with water sampling:	11 casts
CTD:	5 casts
XCTD:	49 drops (includes 7 drops for response test)
Shipboard ADCP measurements:	continuous
Surface temperature, salinity measurements by intake method:	continuous
Surface meteorology:	continuous
Atmospheric sounding:	72 launches
Doppler radar measurements:	continuous

LIDAR measurements:	continuous
Multi-narrow beam, gravity meter, geo-magnetometer:	continuous

3. Period, port of call

February 12, 2000 - March 26, 2000
Ports of call

Sekinehama, Japan	(Departure; February 12, 2000)
Sendai, Japan	(February 13, 2000)
Majuro, Marshall Islands	(February 22-23, 2000)
Guam, USA	(March 18-19, 2000)
Hachinohe, Japan	(March 24, 2000)
Sekinehama, Japan	(Arrival; March 26, 2000)

4. Chief scientist

Yoshifumi Kuroda (JAMSTEC)
Japan Marine Science and Technology Center (JAMSTEC)
2-15, Natsushima, Yokosuka, 237-0061, Japan