
1. Introduction

Oceanic conditions in the subtropical and subarctic gyres, especially in and around the Kuroshio Extension, are thought to be important to the North Pacific decadal/interdecadal climate variabilities. In terms of global heat budget, the ocean in this region transfers the heat obtained in the tropics to the atmosphere. The area could also be a reservoir of greenhouse gases as anthropogenic CO₂ by deep oceanic convection in winter season, which may convey these gasses to deep ocean. Main objectives of this research are to clarify the various processes in this region such as the variability of the Kuroshio Extension and mesoscale eddies, and distribution of the North Pacific Intermediate Water around the Kuroshio Extension.

And We study the historical change paleoceanographic conditions in the North Pacific Ocean. The time scales are from several hundred to thousand years. We research the north and south transfer of Kuroshio Extension area for the past twenty thousand years. We carried out sediment coring. We estimate paleoceanographic condition and paleoclimate from the sea floor sediments analysis.

This cruise is joint study Meteorological observation and Geophysical survey.

There are two Meteorological observation. The first is over the atmospheric aerosol particles. It is generally admitted that atmospheric aerosol particles have impact to the global climate directly and indirectly. The direct effects of aerosols on the climate are due to scattering solar radiation and absorbing infrared radiation. Aerosol particles also may indirectly influence on cloud formation process. To examine the effect of aerosols to the global climate, it is suitable to do the measurements of aerosols in oceanic atmosphere, whose aerosols are well-known as background aerosols. We have measured the background aerosol particles on board in the past fifteen expeditions of the R/V Hakuho Maru, Ocean Research Institute, the University of Tokyo. Main purposes of this cruise are the test of the Kyoto observation on ship and the search of the best place for the sampling inlet.

The second is to clear and solve the problems of horizontal distribution and optical properties of aerosols, some observations using a kind of the module were carried out over the Northern Pacific Ocean. Furthermore, collections of the data for calibration and validation to the remote sensing data were performed simultaneously.

We conduct the geophysical survey to reveal the detailed process of the reorganization of the plate boundaries around the Pacific plate in Late Jurassic before the formation of Shatsky Rise. Bathymetric survey by a multi-narrow beam echo sounder exposed several troughs, which strike is NW–SE or E–W. There are negative magnetic and gravity anomalies over the troughs.

This cruise is certainly consist of atmosphere, watersphere and landsphere comprehensive observation study.

2. Summary

2.1 Ship

R/V Mirai
Captain Masaharu Akamine
Total 35 crew members

2.2 Cruise code

MR99-K04

2.3 Project name

Six kinds of project have been carried out in this joint cruise MR99-K04.

1. Kurishio Extension Study
2. Palocriamate study
3. Study on aerosol particles over the North Pacific Ocean
4. Studies on behaviors and climate influence of atmospheric aerosol and clouds over the subtropical and subarctic region of the Northern Pacific Ocean
5. Validation for TRMM over Northern Pacific with shipboard Doppler radar
6. Geophysical Survey

2.4 Undertaking institution

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

2.5 Chief scientist

Hirofumi Yamamoto (JAMSTEC)

2.6 Period

July 23, 1999 – August 19, 1999

2.7 Post of call

Sekinehama, Japan (Departure; July 23, 1999)
Shimizu, Japan (August 3-5, 1999)
Sekinehama, Japan (Arrival; August 19, 1999)

2.8 Research participants

Total 35 scientists and technical staff participated from 10 different institutions and universities.

2.9 Observation summary

2.9.1 Kurishio Extension Study

In order to clarify the mesoscale oceanic structure, various kinds of observations have been carried out in and around the Kuroshio Extension (including subtropical region and the Kuroshio-Oyashio interfrontal region).

1. CTD casts along 4 sections (150.0E, 152.5E, 155.0E, and 157.5E) across the Kuroshio temperature, salinity, dissolved oxygen and dissolved CO₂ measurements.

CTD (Salinity, Temperature, Depth, Dissolved Oxygen, CO₂) : 48 casts down to 2000m(37 CTD casts), 4000m(9 CTD casts), 6500m(2CTD casts validation)

2. Mooring services: recovery and deployment of subsurface mooring of current meters at 37.5N, 152.5E
 ADCP buoy recovery : 1 site (37° 9.338'N, 152° 8.347'E, Depth=5982m)
 ADCP buoy deployment : 1 site (37° 9.206'N, 152° 8.865'E, Depth=5987m)
3. XBT/XCTD/Bathymetry observations
4. Surface meteorology
 continuous
5. ADCP measurements
 continuous
6. Doppler radar measurements
 continuous
7. Surface temperature, salinity measurements by intake method
 continuous
8. Paleo climate study in the western North Pacific
 We study the historical change paleoceanographic conditions in the North Pacific Ocean. The time scales are from several hundred to thousand years. We research the north and south transfer of Kuroshio Extension area for the past twenty thousand years. We carried out sediment coring. We estimate paleoceanographic condition and paleoclimate from the sea floor sediments analysis.
 Piston coring : 3 sites (40° 3.3'N, 142° 5.0'E, Depth=1555m)
 (40° 5.0'N, 149° 1.0'E, Depth=5608m)
 (37° 0.0'N, 152° 0.0'E, Depth=5848m)

2.9.2 Surface meteorology observation

1. Study on aerosol particles over the North Pacific Ocean

In order to clarify the effect of aerosols to the global climate, marine aerosols and gasses have been measured. The kytoon observation up to about 700m above the sea level and the search of the best place for the sampling inlet have also been carried.

2. Studies on behaviour and climate influence of atmospheric aerosol and clouds over the subtropical and subarctic region of the Northern Pacific Ocean

To obtain the data for calibration and validation between remote sensing and surface measurements over the ocean, a series of simultaneous observations has been carried out about optical properties like as scattering and absorption coefficients and radiative properties as optical properties of atmospheric, the concentration and size Pacific Ocean for 28 days from July 23 to August 19, 1999. In addition of that, a sky radiometer was examined for to a fully automated ship-borne instrument and improved to the practical usage on same board.

2.9.3 Validation for TRMM over Northern Pacific with shipboard Doppler radar

Main theme to use Doppler radar is to investigate the structure of precipitation cloud system which develops over Northern Pacific Ocean, comparing with TRMM/PR (Tropical Rainfall Measuring Mission / the Precipitation Radar, the first spaceborne radar) data

2.9.4 Geophysical Survey

The survey area is situated southwest of Shatsky Rise. The seafloor age of the area is about 150 Ma just before the formation of Shatsky Rise. The gravity anomaly in the area from satellite altimeters (Sandwell and Smith, 1997), which is below -20 mgal, has a linear feature. The interval of survey lines was 5.5 nm and the length was 70 or 80 nm. The ship speed was about 15 knot. We used a proton magnetometer, a shipboard three components magnetometer for the geomagnetic measurement, a multi-narrow beam echo sounder with a sub-bottom profiler, SeaBeam 2112 system, for the bathymetric measurement, and a shipboard gravimeter for the gravity measurement.

2.10 Observed oceanic and atmospheric conditions

Leg.1 Sekinehama to Shimizu (23th July – 3th August)

It was misty condition from the evening to 9pm of 24th. Visibility was so bad. The observation area was taken on the south-west of a high pressure area. It prominent south-west direction of this. The velocity of the wind was 4 classes. It was fine days.

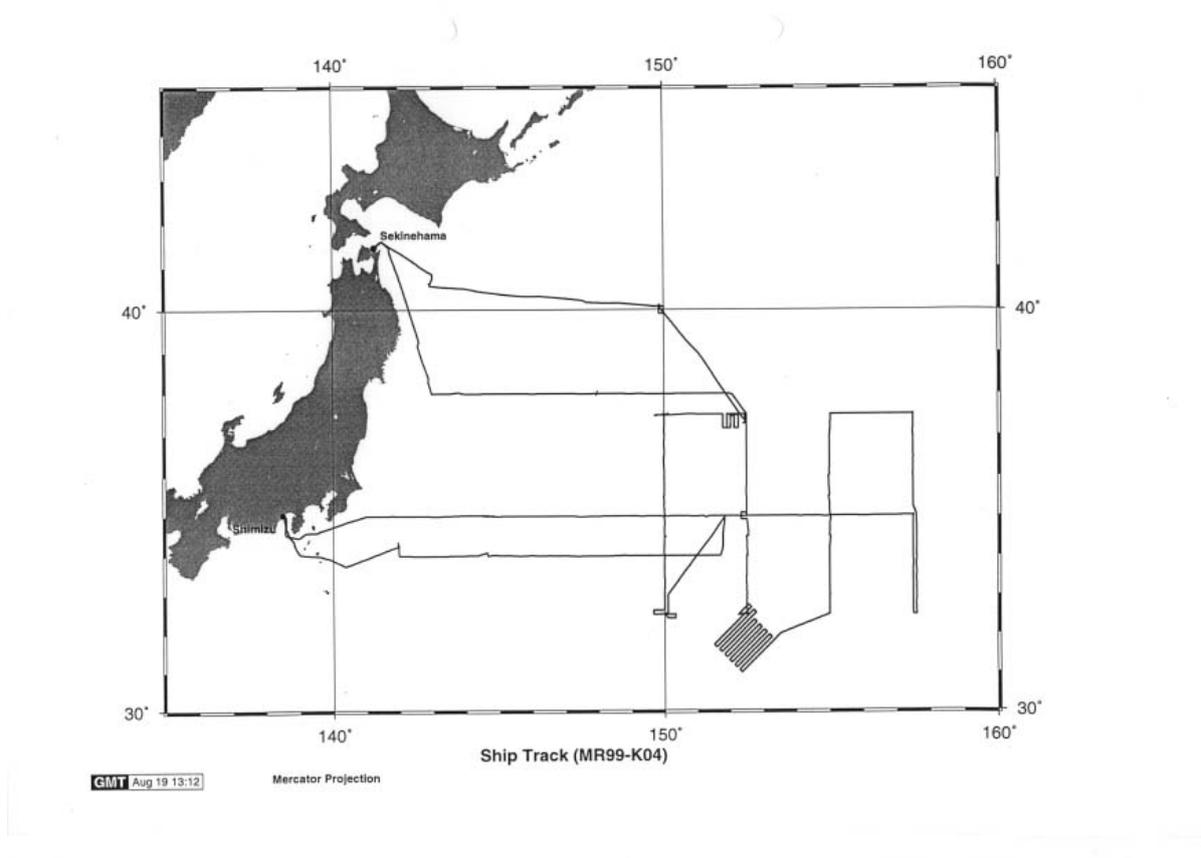
Leg.2 Shimizu to Sekinehama (5th August – 19th August)

We headed east port between a typhoon 8th and high pressure area after Shimizu port. It continued the eastward swell(max 3m) on 6th morning of this. It continued calm weather on the CTD observation area by the effects of the high pressure area. The wind of the area were various direction. The velocity of the wind changed 3 – 4 classes. It was prominent the south-westard wind which blowing in the low pressure zone near the north of Sahalin from CTD observation area to Sekinehama.

3. Cruise Track

The Leg1 left Sekinehama port for Sanriku offing. We observed this Area. A few days later arrive at Shimizu port. The Leg2 left Shimizu port for Sanriku offing. A few days later arrive at Sekinehama port.

Figures & Photos :



Cruise track during MR99-K04



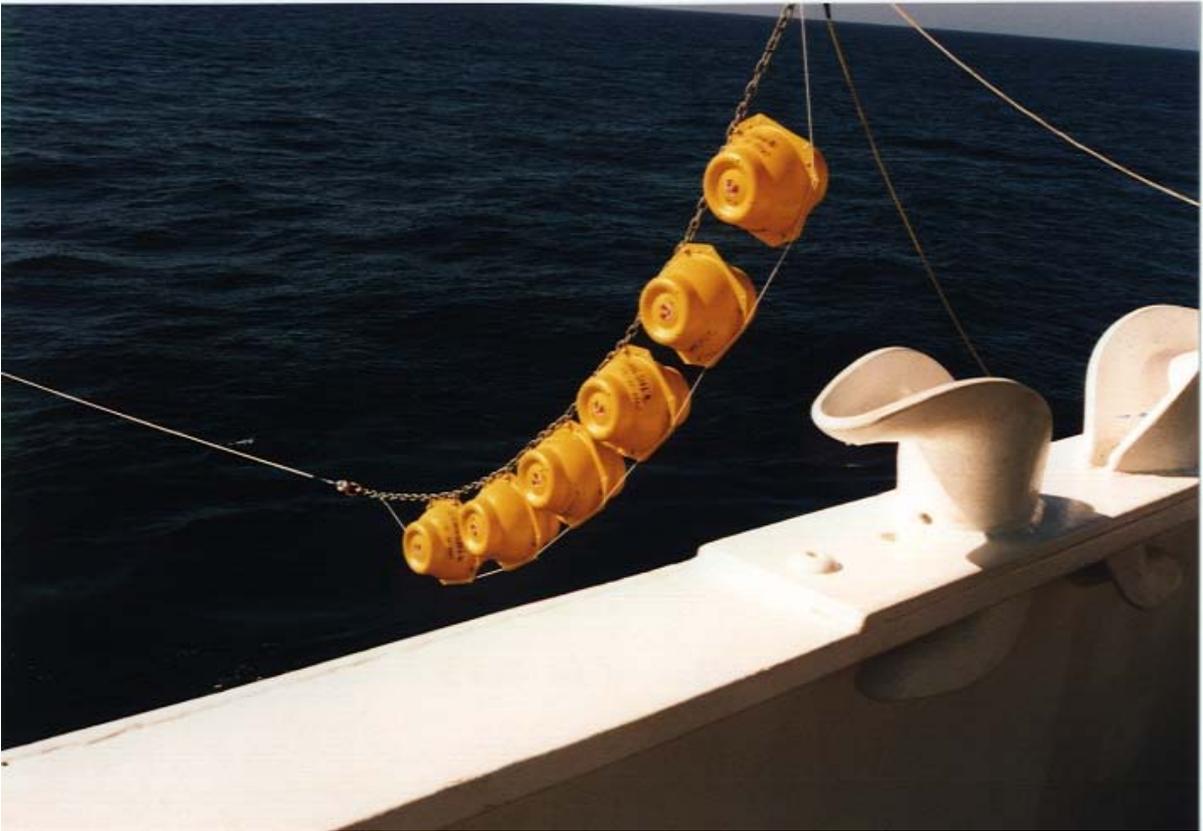
CTD observation



Dissolved oxygen analysis



Deployment of current meters of mooring buoy



Glass buoys



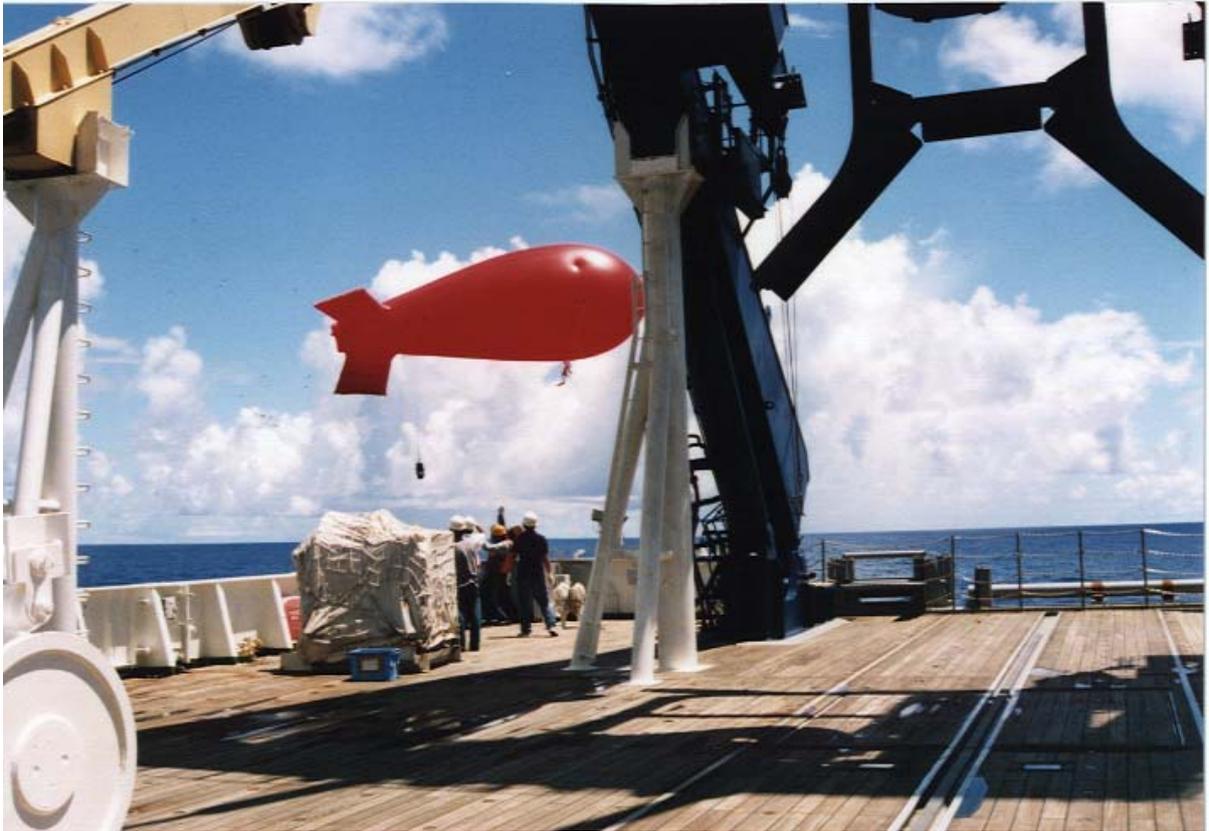
Piston corer (medium diameter : 80m)



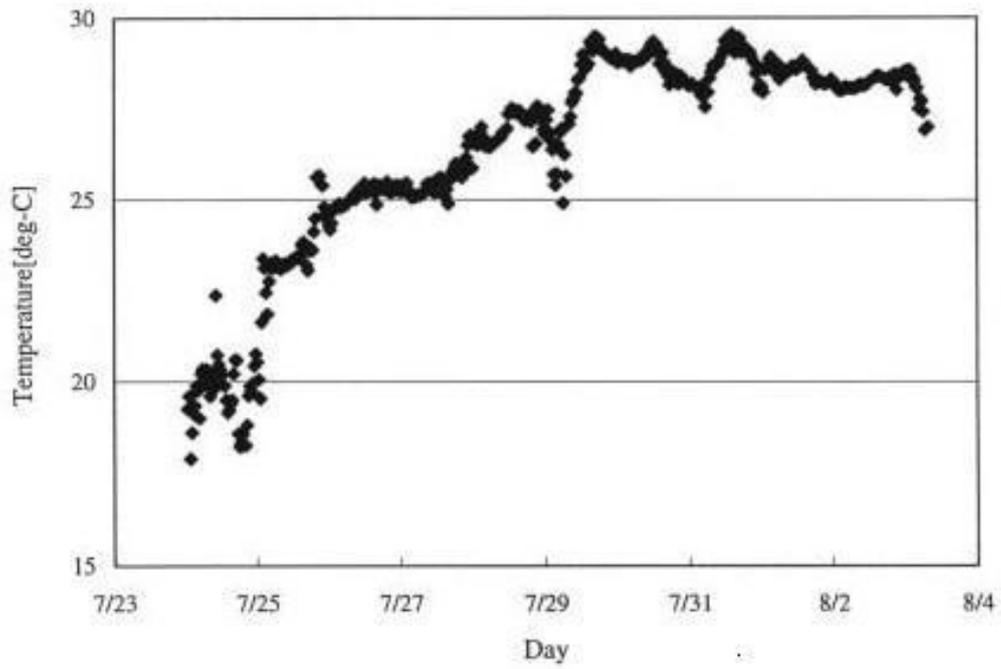
Piston corer (large diameter:115m)



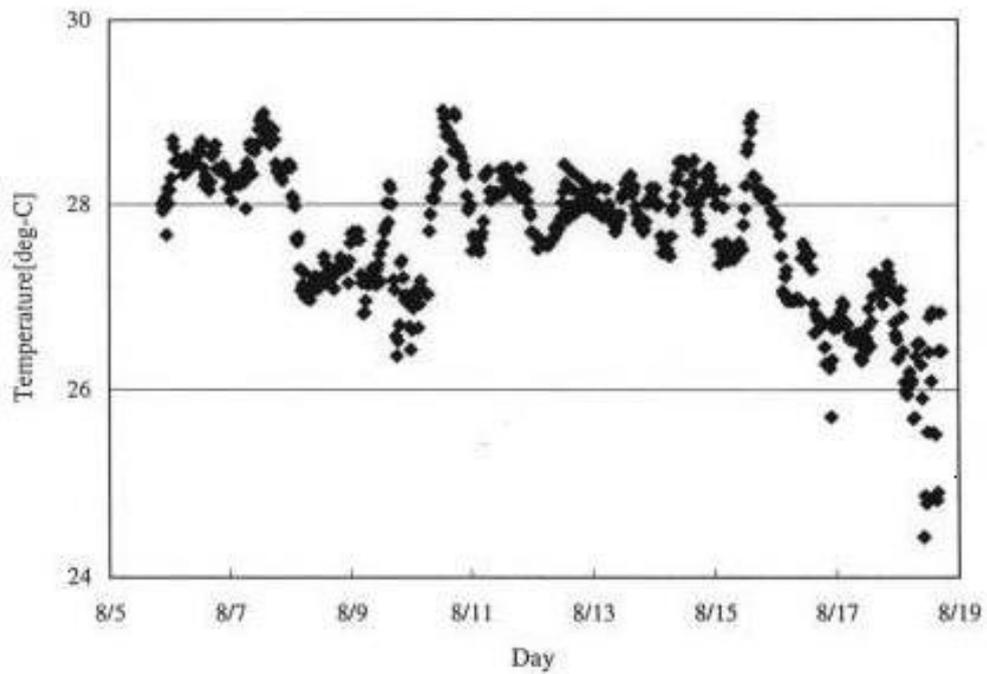
Sampling of bottom surface sediments



Aerosol observation by using a captive balloon



Distribution of sea surface temperature in the first Leg.



Distribution of sea surface temperature in the second Leg.

Sea surface temperature