KESS cruise outline, R/V Revelle 2005, Watts Leg

Area

Western North Pacific
140E-150E
30N-40N

Bathymetry in region is ~5000-6000 m deep and relatively flat, with some seamounts. Strong upper currents can be expected in the Kuroshio Extension and its associated rings.

Itinerary and Timeline

Yokohama	Japan	Mobilization	Wed-or-Thur	June 15-or-16, 2005	
Yokohama	Japan	Depart	Thur-or-Fri	June 16-or-17, 2005	1600hrs
Yokohama	Japan	Arrive	Sunday	July 17, 2005	0800hrs
Yokohama	Japan	Demobilization	Monday	July 18, 2005	

Cruise Description

The following describes the 2nd leg of KESS 2005 sea-going operations. Randy Watts will be chief scientist. This leg will be 30 sea-days. This cruise is a mid-experiment "turn around" and collection of telemetered data. About 50 CPIES were deployed in the Kuroshio Extension in 2004. [Nelson Hogg from WHOI will be chief scientist on the 1st leg, described elsewhere.]

Six main activities for Watts 2nd leg of KESS operations.

1. Telemeter data from 43 CPIES (Current and Pressure recording Inverted Echo Sounders).
2. Recover 3-6 CPIES.
3. Deploy 7-10 CPIES.
4. Take CTD profile at each CPIES site.
5. Conduct CTD & ADCP feature survey
6. Launch ARGOS profiling floats.
7. Conduct atmospheric soundings.

CPIES

A CPIES mooring involves two 17" glass spheres connected by 50 m cable, and a 150 lb anchor stand. The bottom 17" sphere weighs about 70 lbs in air. We "talk" to the instrument acoustically through one of your hull-mounted 12kHz transducers. (two-way communications, sending commands and receiving telemetry).

Telemetry: At each CPIES site we can telemeter data from the CPIES using acoustic telemetry. This operation works best if the ship is close to the CPIES site and ship noise is minimal. We will telemeter data from the CPIES deployed in 2004 (except for instruments marked for recovery.)

Launch: We prefer to launch off the stern using an air tugger and block on the stern A-frame.

Recovery: We require a TAIYO Radio Direction Finder (RDF) receiving on Channel 77 at 156.875 MHz. At the CPIES site we send an acoustic release command to the instrument. After the instrument separates from its anchor, it rises to the surface. The CPIES has a flasher and radio beacon. Without an RDF the CPIES can be located visually, however, the RDF facilitates the recovery process.

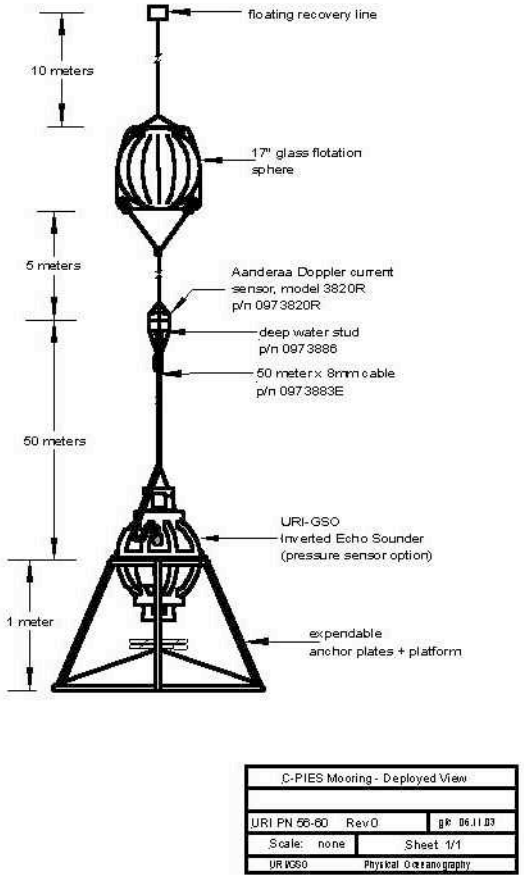


Figure 1. Schematic of CPIES

CTD operations

CTD casts will be taken, surface to bottom, at all above sites (~60), plus about 80 more casts taken to 1200 - 1500 m depth for a detailed feature survey conducted during a 6-day interval. Bottles will be taken during hydrocasts, no more than 24 per cast.

Scripps Institution of Oceanography's Ocean Data Facility, ODF, will provide CTD support. Personnel include a CTD technician, a marine technician and a CTD data specialist during the cruise. Equipment provided by ODF includes SBE CTD system, salinometer. A back-up CTD system and salinometer should be provided by the R/V Revelle.

ARGO profiling floats

Each ARGO profiling float is typically 2 to 2.5 m long and up to 30 kg in weight. Argos profiling floats will be deployed at ~6 CPIES sites. Floats will be deployed just after CTD cast completion and can be easily lowered over the stern by hand to the water.

Shipboard ADCP

The Hydrographic Doppler Sonar System (HDSS) was a major reason that we requested the R/V Revelle for our field work. Specifically, the 50 kHz system measures the ocean currents to depths near 1000 m. We do request exclusive scientific use of the data for two years from July 2005. We have contacted R. Pinkel regarding the system (November 2004) and our specific needs for the cruise. Watts visited Scripps in November 2004 to become familiar with the sonar system and processing. We will continue to work with R. Pinkel and his group regarding any technical issues as they arise, and as we understand the system better.

Atmospheric Soundings

A Japanese group from Hokkaido University (Drs. Yoichi Tanimoto, Masami Nonaka, and Hisashi Nakamura), together with Dr. Shang-Ping Xie (University of Hawaii), have previously conducted atmospheric soundings across the Kuroshio Extension from Japanese research vessels. For an individual sounding, a balloon is released from the ship and measurements of temperature, pressure, humidity, and wind velocity are radioed back to a ship receiver. During this operation, the ship is not required to stop, nor make special maneuvers. These operations require 20 tanks of helium gas which weigh 50 kg each.

Cruise Plan (see Figure 2)

Telemetry + CTD: We anticipate that on-station time for telemetry + CTD will be about 4 hours. Except for stations within the high-speed Kuroshio Extension (~8), CTD casts and CPIES telemetry will be conducted simultaneously. In the high-speed current there will be no overlap between operations. Typical time for telemetry is 2.7 hours. Bottles will be taken for salinity. At some stations, ARGO profiling floats will be deployed and at some stations atmospheric soundings will be conducted.

CPIES Deployment: We anticipate that on-station time for deployment will be around 5 hours. The CPIES will be launched first. Typical descent rate for CPIES is 80 m/min. When the CPIES is ½ hour from the bottom, the CTD cast will begin. Bottles will be taken for salinity.

CPIES Recovery: At some stations we will recover and redeploy CPIES. Recovery requires about 2 hours. An acoustic command signal triggers a 'burn wire' and the CPIES separates from its anchor (15-20 minutes) and rises to the surface at 90 m/min. The CPIES is equipped with a radio beacon and flasher.

The steaming time between CPIES sites is ~4.5 hours.

CTD feature-survey

We will also conduct a feature survey. The large-scale survey provided by the CTD profiles at each CPIES along with near-real time SST imagery and altimeter SSH data will enable us to select a location for the high-horizontal resolution survey. We anticipate that in a 6-day survey we can expect to take 80 casts to 1200 -1500 m depth covering a 120-130 km region with an average 15-km station spacing. The 50 kHz Sonar system is essential to this component.

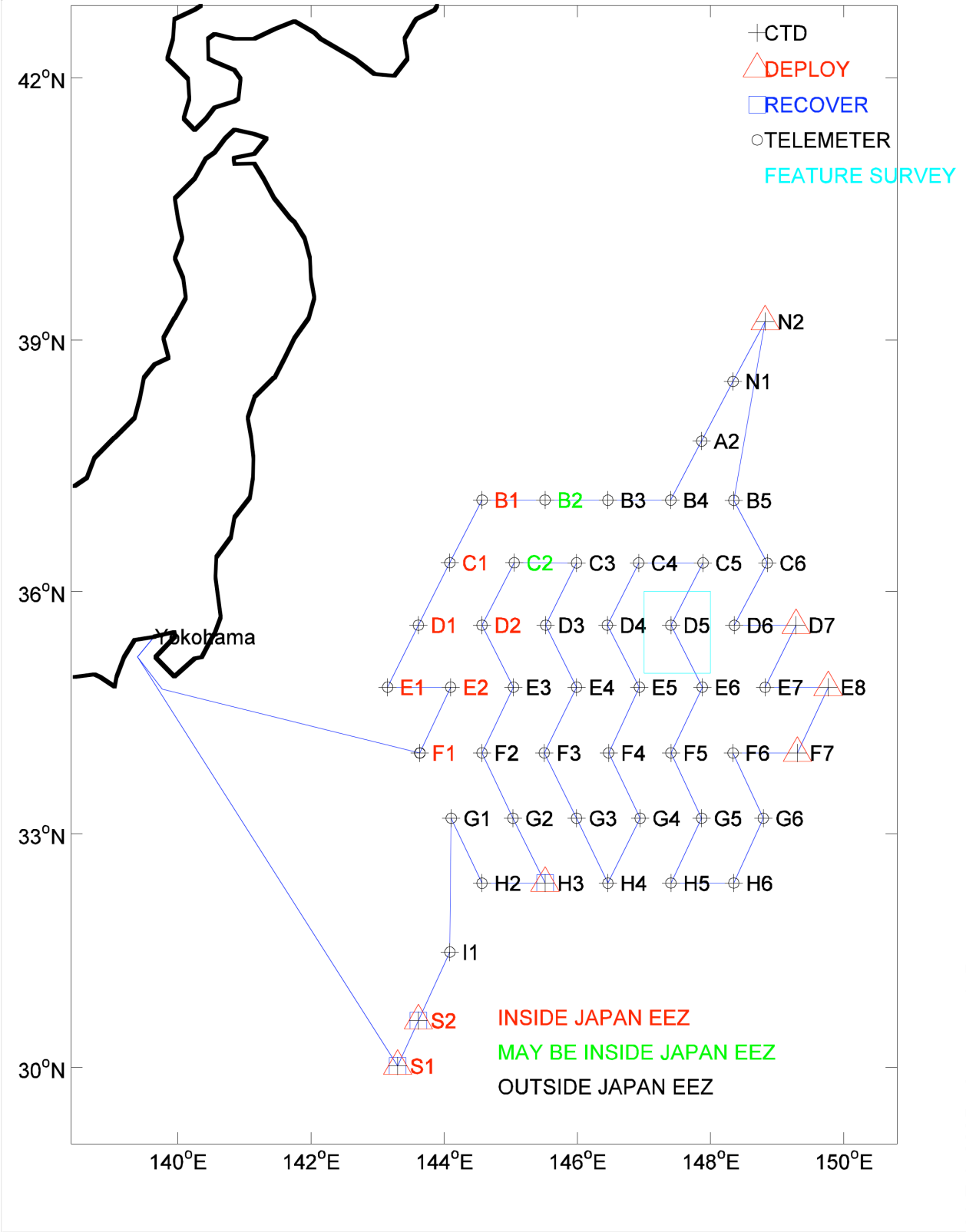


Figure 2. Anticipated CPIES station sequence and operations during the cruise (circles = CPIES telemetry, triangles = CPIES deployment, crosses = CTD casts, squares = CPIES recovery). After most CPIES have been serviced, an approximately 6-day high-horizontal resolution CTD feature survey will be conducted within the above region.

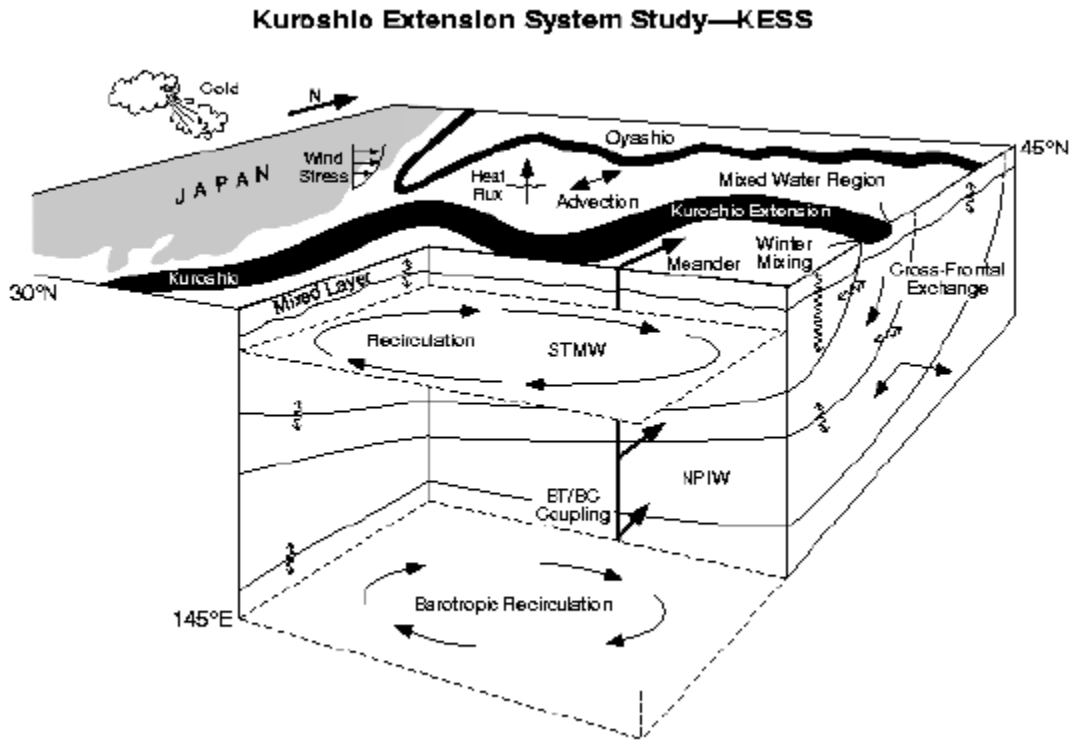
Project Summary

The warm, northward-flowing waters of the Kuroshio western boundary current leave the Japanese coast to flow eastward into the North Pacific as a free jet---the Kuroshio Extension. The Kuroshio Extension forms a vigorously meandering boundary between the warm subtropical and cold northern waters of the Pacific. A recirculation gyre exists to the south of the Kuroshio Extension. Another may exist to the north. This is also one of the most intense air--sea heat exchange regions on the globe, where the warm Kuroshio waters encounter the cold dry air masses coming from the Asian continent. The Kuroshio Extension system exhibits variations which strongly affect North American climate. Among the diverse fields that will benefit from this work are fisheries and climate research, and understanding storm tracks.

Understanding the processes that govern the variability of and the interaction between the Kuroshio Extension and the recirculation gyre is the goal of this study. Processes coupling the baroclinic and barotropic circulations will be examined by case studies of the local dynamical balances, particularly during strong meandering events. The mechanisms by which water masses are exchanged and modified as they cross the front will be characterized. The objective is to determine the processes governing the strength and structure of the recirculation gyres in relation to the meandering jet.

Principal Investigators cooperating from three US institutions postulate dynamical and thermodynamical connections from mesoscale eddies to gyre-scale recirculations and to global climate variations and propose observations designed to test these hypotheses. They will deploy a state-of-the-art array consisting of moored-profiler and current-meter moorings and inverted echo sounders equipped with near-bottom pressure and current senors. Shipboard surveys will conduct case studies of the water properties and currents throughout the water column. Profiling floats will monitor the temperature and salinity structure in the recirculation gyre south of the Kusohio Extension. The proposed approach makes extensive use of satellite data (surface temperature and sea-surface height). They will also collaborate closely with Japanese scientists studying the overall Kuroshio system.

The Kuroshio Extension system is the right place to test hypotheses formulated from previous observational and modeling studies because of its distinct stratification, bathymetry, and thermohaline circulation. The time is right to conduct a study of the Kuroshio Extension system. Over the last several decades a number of substantial programs have been undertaken, focussed on different parts of these western boundary currents, mostly in the Atlantic. These include studies of the Brazil-Malvinas Confluence, the Western Tropical Atlantic Studies, the Subtropical Atlantic Climate Study, and the North Atlantic Current Study. The program that is most closely related to this proposal and, arguably the most ambitious, was the Synoptic Ocean Prediction Experiment. These studies fundamentally changed the scientific community's understanding of the interconnected system of currents, recirculations, eddies, cross-frontal exchange mechanisms, and processes affecting the upper ocean heat budget.



Dynamic and thermodynamic processes in the Kuroshio Extension System. Meanders of the jet couple with barotropic eddies to cause cross-frontal stirring and exchanges of heat, salt, and potential vorticity. These exchanges, along with surface heat fluxes and advection, alter the structure of the recirculation gyre and the upper ocean heat budget. Strong wintertime cooling deepens the mixed layer to form subtropical mode water, which recirculates in this region, retaining the memory of former winters. (courtesy B. Howe, APL)