Shallow and Deep Current Variability in the Southwestern Japan/East Sea

D. Randolph Watts

Graduate School of Oceanography
University of Rhode Island
South Ferry Road
Narragansett, RI 02882
phone:(401)874-6506; fax: (401)874-6728; email: rwatts@gso.uri.edu

Mark Wimbush

Graduate School of Oceanography
University of Rhode Island
South Ferry Road
Narragansett, RI 02882
phone: (401)874-6515; fax: (401)874-6728; email: mwimbush@gso.uri.edu

William Teague
Naval Research Laboratory
Stennis Space Center
MS 39529-5004
phone: (228)688-4734; fax: (228)688-5997; email:wteague@nrlssc.navy.mil

Zachariah Hallock
Naval Research Laboratory
Stennis Space Center
MS 39529-5004
phone: (288)688-5242; fax: (288)688-5997; email:zhallock@nrlssc.navy.mil

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LONG-TERM GOALS

We seek to understand the physics of the mesoscale circulation in the Japan/East Sea, with our efforts focusing on the southwestern region where the variability is especially energetic.

OBJECTIVES

(1) To observe the time-varying transports of the three branches of the Tsushima Current in the Ulleung Basin. From the observations, we will produce daily maps of the upper layer circulation

and path variability of the Offshore Branch and East Korean Warm Current, with mesoscale resolution.

(2) To understand the physical coupling between the shallow and deep currents and eddies within this region, where large-amplitude meanders and steep loop formations occur.

(3) To quantify cross-frontal and vertical fluxes associated with mesoscale processes in the East Korean Warm Current.

APPROACH

A two-dimensional array of 25 pressure-gauge-equipped inverted echo sounders (PIES) was deployed in the Ulleung Basin, which covers roughly a 250-km square region between Korea and Japan. To level the pressure measurements, we also deployed 13 current-meter moorings (CM). These moorings augmented a set of 4 moorings deployed by the Korean Ocean Research and Development Institute

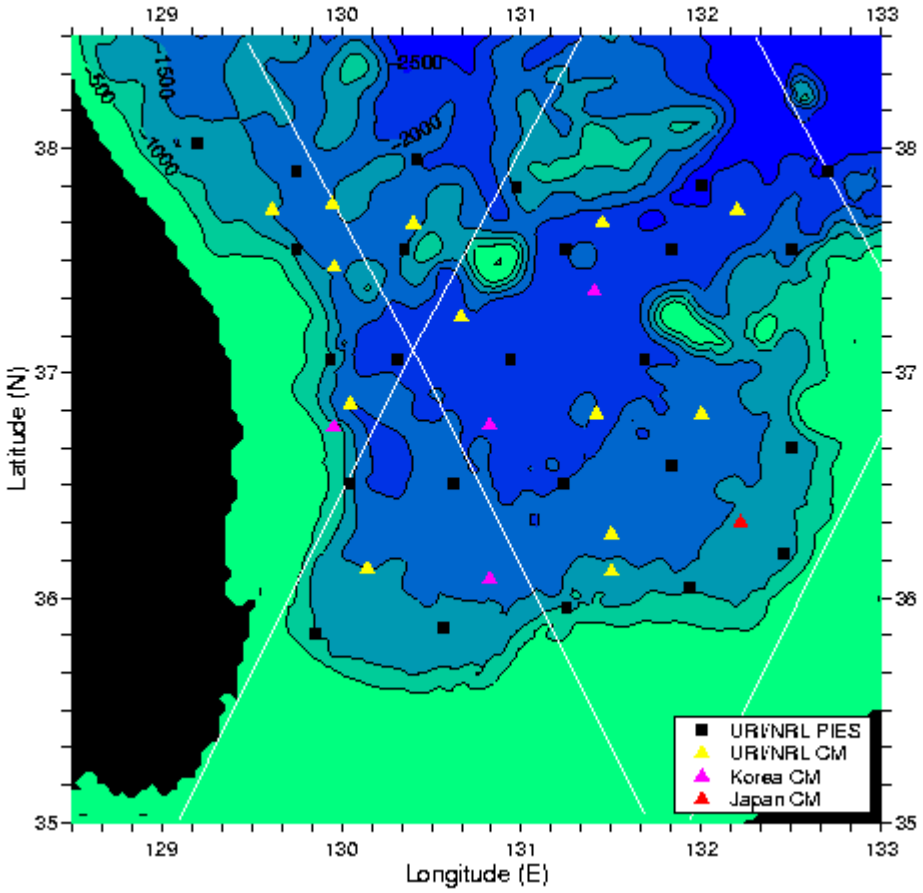

Figure 1. The moored array in the Ulleung Basin of the Japan/East Sea. The instruments are as labeled in the key with squares designating PIES sites and triangles for CM sites. TOPEX / POSEIDON altimeter ground tracks are indicated by the white lines. The bottom depths are color-coded with shallow depths indicated by green and deeper depths by hues of blue; bathymetric contours are labeled in meters. The eastern portion of the Korean Peninsula is on the left, and a segment of Honshu, Japan is at the lower right.

(KORDI, Dr. M.-S. Suk) and an additional mooring installed by the Research Institute for Applied Mechanics at Kyushu University (RIAM, Dr. J.-H. Yoon). The combined array is shown in Figure 1. These instruments will provide two-year time series of dynamic height, vertical shear, and deep current fields, enabling us to map the upper and deep absolute current structure on a daily basis.

WORK COMPLETED

A large fraction of the instrumentation used in the field program was already available. However, the DURIP award provided the necessary funding to purchase the additional equipment needed to conduct the full field program.

In June 1999, a 2-week cruise aboard the R/V Roger Revelle was conducted to deploy the moored instrumentation. Prior to deployment, all CM releases were lowered on a wire to 1000 m to pretest their performance at cold temperatures and high pressures. Following each deployment we acoustically tracked each instrument to the bottom and communicated with it to verify its performance. An expendable bathythermograph was launched at each PIES site after its deployment to provide calibration information. We also carried out three test deployments of a new model PIES.

It was particularly important to coordinate our instrument positions with Korean deep-crab fishing captains. There is intense fishing and crabbing in the Ulleung Basin, including bottom fishing at depths as great as 2,000 meters. KORDI scientists, led by Dr. Moon-Sik Suk, kindly arranged a meeting with the fishing captains union during the Spring 1999 in order to minimize potential interferences between the activities of our two groups. During the cruise when we encountered concerned fishermen in their boats, Dr. Suk was able to conduct on-site negotiations to allay their fears or to reposition moorings when necessary. After the cruise, diagrams of the instruments and their positions were supplied to the fishing captains.

RESULTS

All the proposed instruments have been moored as planned in the Japan/East Sea. Recovery will be in 2001. So no time series data are yet available for analysis. We have begun preliminary analyses of historical hydrographic data in order to produce vertical profiles of temperature, salinity, and specific volume anomaly as functions of acoustic travel time. These will constitute the basis for our techniques for interpreting the PIES data after the instruments have been recovered.

Testing of the new model PIES verified successful performance of the acoustic command system and pulse-delay data-telemetry method. However, after a short deployment, we discovered an oil leak in the acoustic transducer. The leak was traced to a manufacturing problem, which has subsequently led to a procedural / testing change by the transducer manufacturer. Because of this problem, we postponed until October 1999 additional testing of the acoustic performance in deployments as shallow as 375m (which are acoustically more difficult than deep deployments). In all other aspects, the new model PIES worked properly.

A cruise report is being prepared by a URI undergraduate student who participated in the cruise as part of his training.

IMPACT/APPLICATION

We expect that our data will map the seasonal and time-dependent meandering of fronts in the Ulleung Basin, and that it will be used to verify numerical models of the Japan/East Sea and be assimilated into models such as at NRL.

TRANSITIONS

German and Japanese scientists are planning to use the new model PIES for research in the Denmark Strait, off Brazil, and in regions of the Kuroshio and the Kuroshio Extension.

RELATED PROJECTS

Surface-to-bottom hydrographic measurements are being collected by Lynne Talley (SIO) throughout the Japan/East Sea, and at our PIES sites in particular. These data will be used in conjunction with available historical hydrographic data to produce vertical profiles of temperature, salinity, and specific volume anomaly as functions of acoustic travel time to interpret our PIES measurements.