The Kuroshio off Southern Japan: Analysis of Data from the Asuka Study

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LONG-TERM GOAL

Determining Kuroshio and Kuroshio Countercurrent transports of volume, heat, and salt off Shikoku, Japan, and their fluctuations on times scales of days to years.

OBJECTIVES

(1) Characterising the structure of Kuroshio variability off Shikoku at time scales from 1 day to 1 year.

(2) Determining Kuroshio volume, heat, and salt transports and their flucutations at these time scales.

(3) Developing a simply maintained proxy measurement scheme for Kuroshio volume and heat transports.

(4) Comparing the Kuroshio in this region with the Kuroshio upstream and downstream—also with the Gulf Stream off the coast of Georgia. Establishing and understanding the similarities and differences.

APPROACH

For more than two years, we maintained a 1,000 km array of 8 inverted echo sounders (IES) along a TOPEX satellite altimeter line across the Kuroshio off Shikoku Island in southern Japan. Along the same line, Japanese oceanographers maintained an array of current meters (including moored ADCP's) and carried out frequent (nearly twice a month, on average) hydrographic sections in what was called the ``ASUKA" program.

WORK COMPLETED

We successfully recovered all 8 IES's from the Japanese vessel ``T/V Keiten-maru" in November 1995. Despite some data loss in the shallowest instruments, due to acoustic reflections from the bottom, we obtained good data from all instruments. Processing and analysis of these IES data records and comparison with TOPEX altimeter data and hydrographic data are completed. Recently, our Japanese colleagues made their current-meter data available to us and we are using these for absolute referencing. The initial results from this make up the M.S. thesis of Mr. Jeff Book, who is a student supported on this project.

Note: This grant also provided support for another graduate student Mr. (now Dr.) Charles James to complete writing a thesis and a journal article on results from an earlier ONR-supported study of the Kuroshio in the East China Sea.

RESULTS

James and Wimbush (1995) showed that acoustic echo time is especially strongly related to dynamic height in the Pacific Ocean in a broad region centered on the Kuroshio, where there is a tight linear relationship with typical slope of -5 dyn cm/ms. From 889 ASUKA hydrocasts, we determined that the slope in the ASUKA region (for 0-800 dbar dynamic height) is -5.18 $\pm$ 0.9 dyn cm/ms. This value was used to convert our IES data. By suitably combining the TOPEX altimetry data with our IES data, one can in principle separate the barotropic and baroclinic components of the TOPEX- region were are too small to be resolvable by this technique. Baroclinic SSH fluctuations exceeded 75 cm. Pronounced offshore Kuroshio meanders occurred three times a year, in February, June, and October in both years. These are meanders of up to 50—150 km, lasting 2 weeks to 2 months.

Analysis of the ASUKA hydrocasts revealed the existence of ``gravest empirical modes'' for the temperature and specific-volume-anomaly fields in the region. These were used in conjunction with the IES data—and referencing to the current-meter data where available—to compute the time-varying temperature and velocity fields for the entire section. From these, the mean Kuroshio volume and temperature transports for the two-year period were determined to be 65 Sv and 3.7×10^{15}W, respectively. The Kuroshio volume transport was remarkably variable, ranging from less than 20 Sv to more than 100 Sv, and sometimes changing by more than 40 Sv in just a few weeks.

IMPACT/APPLICATION

Although the Kuroshio is comparable to the Gulf Stream in its importance to heat and momentum transfers in the ocean, our knowledge of the Kuroshio is much less than that of the Gulf Stream. This project is intended to expand significantly our knowledge and understanding of the Kuroshio.

TRANSITIONS

The work was done as part of a coordinated program named ``ASUKA" (Affiliated SUrveys of the Kuroshio off Ashizuri-misaki), involving Japanese oceanographers from Kyushu, Kagoshima, Tokai, Hiroshima, Tokyo, and Mie Universities, and from the Japan Hydrographic Office (Maritime Safety Agency), the Japan Meteorological Agency, and the Japan Fisheries Agency.

RELATED PROJECTS

The first 7 months of the ASUKA deployment period corresponded to the last 7 months of the 22-month deployment period of the KERE array, situated nearly 1,000 km downstream.

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