Doppler Sonar Observations of the Kuroshio in ASIAEX 2000

Robert Pinkel
Marine Physical Laboratory
Scripps Institution of Oceanography
La Jolla California 92093-0213
Phone: (858) 534-2056 fax: (858) 534-7132 email: rpinkel@ucsd.edu

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LONG-TERM GOALS

To gain a more complete understanding of ocean dynamical processes, particularly at fine-scale, through intercomparison of high, mid- and low-latitude observations, both near the sea surface, in the main thermocline, and near the sea floor.

OBJECTIVES

To identify the phenomena involved in the cascade of energy from mesoscales to turbulent scales. To quantify the relationship between fine-scale background conditions and the occurrence of microscale breaking.

APPROACH

Progress is effected through a steady-state cycle of instrument development, field observation and data analysis. The primary instruments employed include Doppler sonar and profiling CTD's. Generically, our instruments produce information which is quasi-continuous in space and time. Measurements typically span two decades in the wavenumber domain. This broad band space-time coverage enables the investigation of multi-scale interactions.

WORK COMPLETED

We have participated in the first phase of ASIAEX (April-May 2000) in the East China Sea. Using the dual frequency Hydrographic Doppler Sonar System on the R.V. Roger Revelle, profiles of ocean currents were obtained to 700 m depth with 15 m vertical resolution and to 250 m with 3 m vertical resolution. In the course of the experiment, several transects of the Kuroshio were performed. The combined sonar and CTD data render a rather complete spatial picture of the hydrographic fields.

Plans to re-visit the area on the RV Melville in May-June 2001 were not realized. Schedule changes resulting from mechanical problems with the ship resulted in the cruise leg being cancelled. Analysis efforts have thus focused on data from year I.

RESULTS

A series of very energetic shear layers were found (by graduate student Luc Rainville) to underlie the base of the Kuroshio. These slope downward offshore and have horizontal coherence scales of 30-50

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14. ABSTRACT
To gain a more complete understanding of ocean dynamical processes, particularly at fine-scale, through intercomparison of high, mid- and low-latitude observations, both near the sea surface, in the main thermocline, and near the sea floor.

15. SUBJECT TERMS

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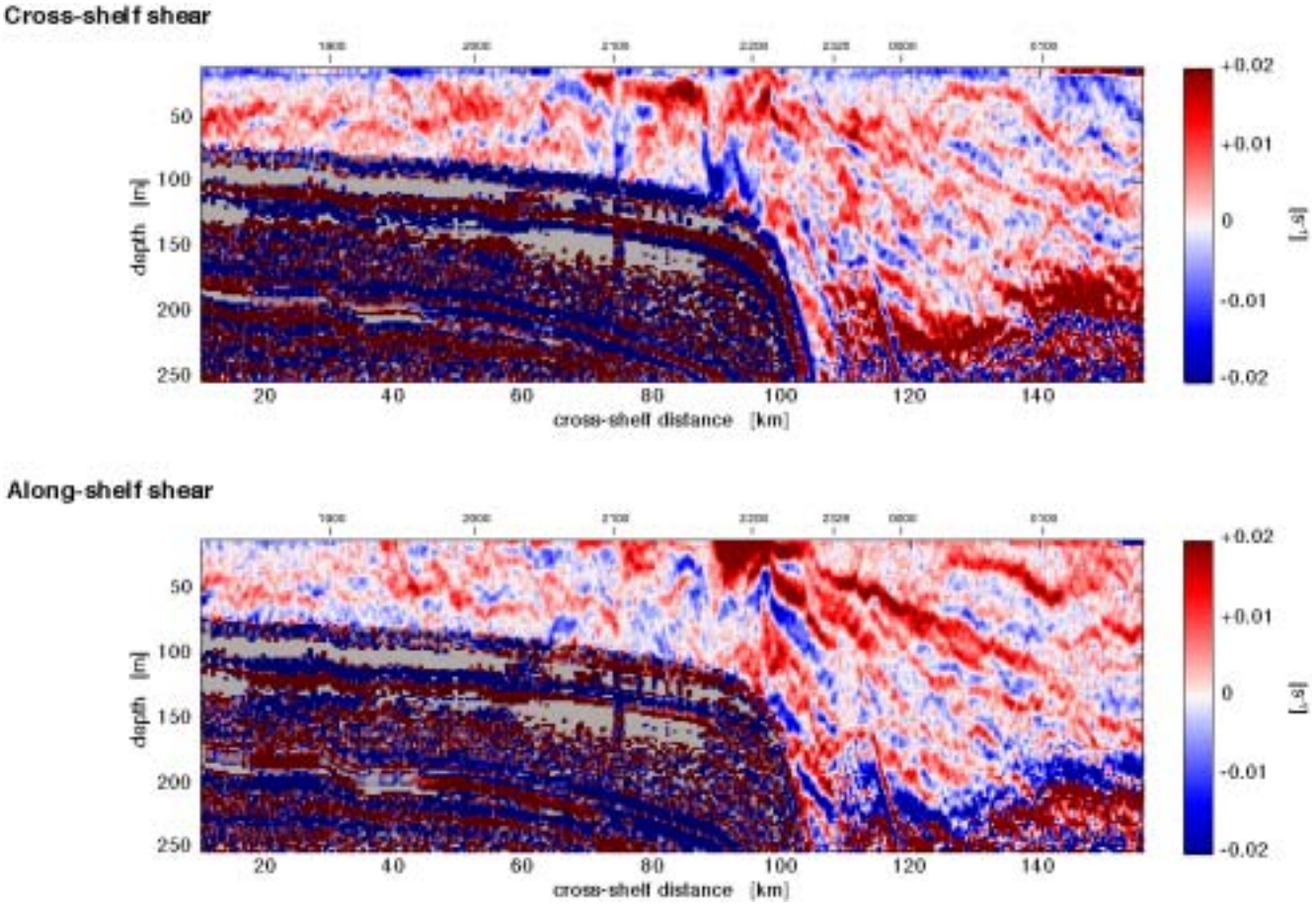
km. The observed slopes slightly exceed the slope of isopycnal surfaces, suggesting that they are waves with a near-inertial intrinsic frequency. The shear associated with these waves is comparable to the geostrophic shear of the Kuroshio.

We have been unable to detect a vertical energy flux associated with the shear. In part, this is a consequence of the short duration of the transect measurements. It is difficult to sense the time-evolution of flow from a moving platform.

If the shear layers are frontal, in approximate geostrophic balance, one would expect to find large horizontal density gradients, perhaps with T-S variations, through the layers. Such variations are not seen.

At present, the analysis is most consistent with the hypothesis that the shear layers are refractively trapped waves, more or less frozen in space by the vertical and lateral shears of the region. With time-series measurements at the site, the issue could be resolved.



1.Maps of vertical shear measured by the High Resolution Sonar (140kHz) near the shelf break on April 17, 2000. For this line, the R/V Revelle was going from the continental shelf to deep water. Time (UTC) are marked on the upper axis of each panel. The bottom topography is indicated by the darker region. The along-shelf current (into the page) is dominated by the Kuroshio, with the front located at the shelf break, at a cross-helf distance of about 95 km.

IMPACT/APPLICATIONS

These organized motions must greatly influence dissipative processes at the Kuroshio Front. In turn, they must be strongly influenced by the meandering nature of the Kuroshio and its interaction with the continental shelf.

The highly coherent, anisotropic, step-like features induced in the density field by the straining of these layers will have a profound influence on the propagation of sound, an influence of relevance to naval operations. Given the strong acoustic signature that these layers must have, an experiment focused on their study might well make use of acoustic techniques.

TRANSITIONS

The Hydrographic Doppler Sonar System on the R.V. Revelle (funded primarily by NSF and the University of California) will be kept in continuous operation for future users of the ship. It is suggested that other ships in the US research fleet might benefit from similar systems.

RELATED PROJECTS

The shear data obtained in ASIAEX will be merged with the CTD data collected by Steve Ramp (NPGS) to produces a comprehensive picture of the region. Observations of wave phenomena at the shelf break and on the shelf will be applied to models of acoustic propagation in the region by Jim Lynch, Tim Duda, and John Colosi of Woods Hole.

PUBLICATIONS

Alford, M.H., R. Pinkel, 2000: Observations of overturning in the thermocline: The context of ocean mixing. J. Phys. Oceanogr., 30, 805-832

Alford, M.H., R. Pinkel, 2000: Patterns of Turbulent and Double-Diffusive Phenomena: Observations from a Rapid-Profiling Microconductivity Probe. J. Phys. Oceanogr., 30, 833-854