Ocean Dynamics

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Award#N00014-94-1-0046

LONG-TERM GOALS

To gain a more complete understanding of ocean dynamical processes, particularly at fine-scale, through comparison of high, mid- and low-latitude observations, 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 meso-scales to turbulent scales. In particular, we wish to quantify the relationship between fine-scale background conditions and the occurrence of microscale breaking.

APPROACH

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

WORK COMPLETED

Our major accomplishment this year has been the execution of the NLIWI South China Sea 2005 VANS-WISE Experiment in April-May 2005. Our objective was to determine whether large non-linear internal waves propagate westward across the S. China Sea, or whether these waves are formed only at the western boundary of the SCS, as the linear internal tide shoals. Using the Hydrographic Doppler Sonar System on the RV Roger Revelle and a new fast-profiling CTD system developed at MPL-SIO (Figure 1), we were able to clearly resolve non-linear wave packets traversing the deep basin of the SCS. We were also able to obtain the first mid-basin observations ($z > 500$m) of these waves.

Figure 1. The fast CTD being deployed from the RV REVELLE. The System packages a SeaBird SBE 49 CTD and a micro conductivity probe in a ~30Kg package suspended from a spectra cable with six imbedded electrical conductors. The system is profiled by a portable electric winch at vertical speeds approaching 12 kts.

RESULTS

We observed the passage of approximately 20 non-linear wave packets. A representative example is given in Figure 2. In contrast to shallow water solitons, these waves lack the intrinsic shear to drive local instability and breaking. They can, however, trigger instability on pre-existing shears. Indeed, the intensity of fine scale shear in the SCS is impressive. Its genesis is presently unknown and worthy of future research.

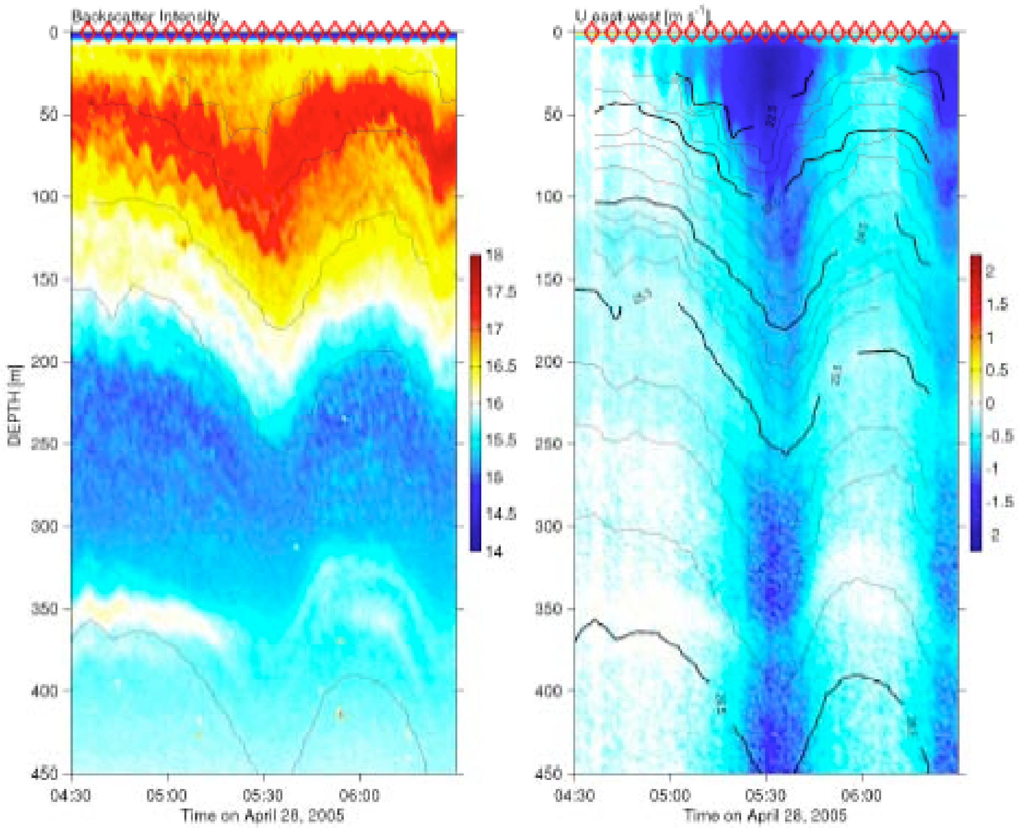

Figure 2. A representative nonlinear wave observation, as seen by the Revelle 140 kHz HDSS sonar (colors) and the FAST CTD (isopycnals). The left panel displays acoustic scattering strength, showing the high frequency waves that frequently accompany the large NLIWIs'. These waves have a very small (<1km) horizontal scale, and may provide the surface scattering signature seen by Bill Plant's radar. The zonal velocity of both the major non-linear wave and the high frequency waves can be seen at right. From the direction of the velocity fluctuation, the orientation of the high frequency crests can be determined relative to the underlying soliton. Even profiling at ~5 minute intervals, the CTD barely captures the high frequency signal.

IMPACT/APPLICATIONS

The SCS 05 data were obtained in conjunction with forward-looking sea-surface radar backscatter measurements made by Dr. Bill Plant of APL-UW. We anticipate being able to co-register our measurements and quantify the under-sea conditions that influence his scattering signatures.

RELATED PROJECTS

The development of the Fast CTD has enabled us to document the SCS density field at a rate (0-500 m depth every 5 minutes) appropriate to the study of non-linear internal waves . The use of this system in the coming IWAP (NSF-06), AESOP (ONR-06), and NLIWI (ONR-07) programs has been enabled by the initial effort.

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

Halle, C.M. and R. Pinkel, 2003: Internal wave variability in the Beaufort Sea during the winter of 1993/94. J. Geophys. Res.