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Scripps Institution of Oceanography

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA, SAN DIEGO
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ADVANCED OCEAN ENGINEERING LABORATORY

TECHNICAL PROGRESS REPORT

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This semi-annual report reflects the technical status of internal wave and microstructure studies conducted ~~within~~ at this Laboratory, the Advanced Ocean Engineering Laboratory at the Scripps Institution of Oceanography.

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PART I. MIDWATER THERMAL STRUCTURE

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PART I

Midwater Thermal Structure

I. This report supplements previous reports on the continued use of a freely floating, yo-yoing instrumented midwater capsule. A summary is given of work for the period July 1, 1975 through December 31, 1975.

II. Technical Report

1. Internal Waves and Microstructure

The bulk of the work in this time period has been concerned with equipment preparations for a 20 day measurement program to be conducted at a nominal depth of 150 m in a location 260 miles southwest of San Diego (March-April, 1976). The primary goal of the experiment is to study temperature and salinity microstructure and its evolution, and to simultaneously obtain internal wave records. Implementation of a microprocessing unit within the capsule will allow both microstructure and wave measurements to be made at the same time. Statistical properties of the microprocessing rather than individual data points will be recorded, thus greatly increasing the possible length of experiments. Use of the microprocessor and a newly installed conductivity probe, hopefully will give us the ability to describe internal waves by the changing elevations of isopycnal rather than isothermal surfaces.

The microprocessor will take over many of the logic functions of the capsule and is expected to increase its reliability as well as its flexibility. A short sea trial is planned in February as part of the preparation for the March experiment.

2. Dropped Horizontal Coherence

An examination of horizontal coherence of vertical fine structure records at small separations (≤ 2 m) is underway. Preliminary results indicate the Garrett and Munk internal wave spectrum adequately describes the observed coherence loss for vertical scales down to less than 1 m for horizontal separations of $>$ 1 m (Williams, 1976).

3. Capsule Dynamics

As a preliminary to future water motion studies in which a passive midwater capsule will be used as a Lagrangian tracer, we are studying the motion of a free capsule in a fluctuating stratified fluid. The analysis of data acquired in Lake Tahoe for that purpose during February and July, 1975 is nearing completion and a report should be finished by the second quarter of this year. Most of the analysis has been confined to the capsule's peculiar descent to its final equilibrium depth. The motion does not obey a simple quadratic drag law, especially during its final stages. Qualitatively, at least, the behavior during part of the capsule's settling out is consistent with a loss of energy by a generation of internal waves.

4. Reference

Williams, G. O. (1976), Internal waves and horizontal coherence of fine-structure (in preparation).

PART II: MICROPROCESSES

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PART II

MICROPROCESSES

During the past six months two major objectives have been reached. The velocity/temperature microstructure device has been developed to a state-of-the-art device, and 50 drops of this instrument have been made in the San Diego bight region of the California Current, and in the frontal system off Baja California. Secondly, a modified Niel Brown CTD has been developed for use in documenting density structures associated with intrusions. Development of the CTD is continuing with a newly designed electrical conductivity cell to reach an accuracy in density sufficient to permit the inference of lateral pressure gradients due to density anomalies.

MSR

In November a study was made of a region of 25 miles lateral extent off Cabo San Lucas. This region was shown by Stevenson to be a frontal system of three distinct water masses - of Northern origin through the California Current, of Mediterranean origin through the Gulf of California, and of equatorial origin, arising from flow northward up the coast of lower North America.

In March 1972, Gregg found intense thermal microstructure in this area associated with extremely strong temperature inversions (greater than 1 degree centigrade), characteristic of strong mixing of dissimilar water types.

Five days were spent on station in November 1975. A surprisingly thermally quiet region was found, with only one temperature inversion in the upper 500 meters of the water column. Several yo-yo surveys were made in an attempt to locate the frontal system. Finally, a drogue was placed at 125 meters to mark what seems to have been a cold water intrusion from the North.

Over a 3-day period the drogue moved westerly with a pronounced sine-wave pattern, suggesting strong tidal influence. Surface currents, as inferred from ship drift, was northwestward at at least 25 cm/sec. This current configuration is more typcial of early summer for this region, according to Stevenson. Typical Surface currents are southeastward in winter.

Thermal microstructure was low by comparison to both previous measurements in this region by Gregg, and by comparison to typical San Diego bight levels found by Cox, Gregg, and Lange. Velocity fluctuations of the order of 10 cm and less in size were not seen, although low level shear structure (of magnitude $<10^{-3}$) was seen and is of interest. This data is presently being analyzed closely and will be the subject of forthcoming papers.

Important redundancy tests of the MSR were also made during this cruise. Velocity probes were mounted side-by-side on one wing of the instrument, and the comparison is proving to be of great value in placing confidence on measured velocity structures. A. Mortensen, a graduate student, made an inter-comparative study of the response times of thermistor flakes by mounting two closely spaced thermistors on the nose of the instrument. Five successful drops were made in this way. They promise to yield information of value in optimizing the choice of thermistor materials and configurations to use in the future, in understanding the measurements that have been previously made with such devices, as well as documenting the anomalously low temperature and velocity fields found in the frontal system in November.

The data collecting capability of the MSR is limited at present to 8 data channels, and a depth range of 90 meters anywhere within the upper 600 meters of the ocean. A large effort has been put into incorporating a Motorola microprocessor and digital recording device in the instrument, to increase the MSR's capability to include sea water electrical conductivity information, as well as extending the operating depth of the instrument. This effort has now reached the stage of software program design and interface management with the MSR. This work is expected to be completed by summer, 1976.

In addition to the above, over 40 drops of the MSR have been made in the San Diego bight. The data from these drops is being investigated and results as to the instrument's performance, and the basic velocity structures characteristic of this region, are being produced. This will be an on-going process involving increasing sophistication in data analysis as the processing of the data continues. Perhaps the single most surprising result to date is that this region is far more quiet in velocity fluctuation levels than anticipated. Most portions of the drops show velocity fluctuations of size 10 cm/s or less at least as low as 0.3 mm/sec, and a few regions of some discernible horizontal motion of small scales. Dissipation rates are uniformly below 10^{-5} ergs/cm^3/sec, which is lower than published velocity microstructure data for similar areas by about a factor of 10 to 50.

The data from these drops promises to provide valuable and enlightening information of a typical offshore bight.

CTD

In preparation for an intrusional study early in 1976, much of the use of the CTD in 1975 was aimed at understanding and improving the density measuring characteristics of the CTD. It appears possible to measure the horizontal gradients in pressure due to density anomalies in the water column - essential information to understanding the spatial and temporal evolution of intrusive water masses. Much of last year's effort has focused on yo-yoing the CTD to provide contour information in temperature, salinity and density.

A modified conductivity cell has been designed and built which we hope will eliminate unwanted spiking in the electrical conductivity information, and at the same time provide higher accuracy in measurements. This cell will be extensively tested prior to the early 1976 intrusional study.

The CTD has been used in conjunction with the MSR to document the San Diego bight, and this information is being used in part by C. Johnson to understand low wavenumber parts of the horizontal temperature spectrum.

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STEVENSON, M. R. (1970) On the physical and biological oceanography near the entrance of the Gulf of California. Bull. Inter-Amer. Trop. Tuna Com., 14(3).

GREGG, M. C. (1975) Microstructure and instrusions in the California Current. J. Phys. Oceanogr., 5(2).