A Finescale Lagrangian Instrument System

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LONG-TERM GOALS

A long range goal of my research is to understand the processes that control diapycnal mixing in the ocean (with particular emphasis on the mixing supported by internal wave breaking), and the consequences of that mixing for the ocean's general circulation.

OBJECTIVES

Our recent work has revealed a strong relationship between internal wave energy levels and the intensity of turbulent mixing in the ocean interior, with evidence for enhanced internal wave and turbulence levels in proximity to irregular bottom topography and within gravity currents downstream from bathymetric sills. Distorted/enhanced internal wave fields and elevated levels of mixing have also been observed near the ocean's free surface. Quantifying the characteristics of the finescale motions in these domains has proven difficult using conventional (bottom-anchored) instrumentation owing in part to the complicating aspect of horizontal advection. The present grant is supporting the testing of a new deployment scheme for the Moored Profiler instrument (a newly operational system developed in part with past support from ONR) in which the Profiler operates on a freely-drifting vertical tether. We hope that finescale velocity, temperature and salinity observations in a Lagrangian framework obtained by the new measurement system will help us better diagnose the physical processes driving the mixing in these regions. Our immediate objective is to quantify the behavior of the Moored Profiler instrument in this new deployment configuration to determine if it will be appropriate for future scientific investigations.

APPROACH

To advance understanding of ocean finescale motions responsible for diapycnal mixing, we wish to acquire time series of finescale shear with temperature, salinity and density information at high vertical resolution following water parcels. Over the last ten years with support from the National Science Foundation, Office of Naval Research, and National Oceanic and Atmospheric Administration, we have developed a new autonomous instrument able to repeatedly traverse a vertical mooring wire carrying sensors through the water column: the Moored Profiler (Doherty *et al.*, 1999; Toole *et al.*, 1999; Morrison *et al.*, 2000, 2001). Prototype instruments fitted with a CTD for measuring ocean temperature and salinity versus pressure, and an acoustic current meter (ACM) that measures ocean currents, were first deployed in support of science during our Littoral Internal Wave Initiative TWIST experiment (Turbulence and Waves over Irregular Sloping Topography).

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14. ABSTRACT
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15. SUBJECT TERMS

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In our analyses of Moored Profiler data, we have found that the effects of horizontal advection makes interpretation of the finescale motions difficult. For example, internal lee waves appear stationary in a coordinate system fixed to the ocean floor, and are thus missed in the usual finescale analysis approach of studying anomalies from time means. A more natural coordinate system to observe finescale motions is one that moves with the water column. The present grant is supporting testing and evaluation of a new deployment scheme for the Moored Profiler in which the vehicle cycles up and down a freely-drifting vertical tether. We call this assembly the Finescale Lagrangian Instrument System (FILIS).

Three possible FILIS deployment schemes are envisioned: a tether drifting just below the free surface to study air–sea interaction and mixed-layer evolution, a neutrally buoyant tether drifting mid-water-column to investigate ocean interior internal waves, and a tether skipping along the bottom to investigate dense overflows. Motivated by ideas for a future Eighteen-Degree Water experiment, we are first testing the near-surface scheme (Figure 1). This design was fine-tuned with guidance from a mooring dynamics analysis carried out by Dan Frye and Jason Gobat. Rick Trask and Jim Dunn are presently constructing the tether depicted schematically in the figure, and Steve Liberatore is preparing a WHOI prototype Moored Profiler for a short (few-day) trial deployment off Bermuda in conjunction with colleagues involved in the Bermuda Atlantic Time Series (BATS) program. We plan to have Scott Worrilow join the BATS cruise of early November, 2001 and deploy the FILIS for an initial test. Analysis of the resulting data will be carried out to establish the behavior of the Moored Profiler vehicle on this tether arrangement.

WORK COMPLETED

Scheduling of the test deployment was constrained by the availability of Moored Profiler instruments; our present inventory of instruments are in heavy demand. We finally had a system returned from sea in early summer 2001 that is now being refurbished and prepared for the test deployment. The tether design (Figure 1) was recently tested theoretically (see above) and is now being assembled. We are planning to ship gear from WHOI to Bermuda in mid-October, and carry out the test deployment off Bermuda in early November.

RESULTS

Given that the field test has yet to occur, our only substantive results thus far concern the theoretical performance of the drifting tether in response to an assumed distribution of surface waves derived from application of Jason Gobat's mooring dynamics program. Those studies suggest vertical motions at the base of the 300-m tether in response to a random wave field with 8-foot significant height and 9 s dominant period will be less than 40 cm. The model analysis also predicts horizontal motions of the tether just below the flotation in these wave conditions will be ± 50 cm/s, but should decrease rapidly with depth and be negligible at the sinker weight. We believe the WHOI Moored Profiler will function satisfactorily under these conditions.

IMPACT/APPLICATIONS

Should the FILIS test prove the viability of this instrument system for examining the time evolution of the upper ocean in response to atmospheric forcing, we have ideas for using FILIS in support of a research program to investigate formation mechanisms of Eighteen Degree Water in the eastern subtropical North Atlantic.

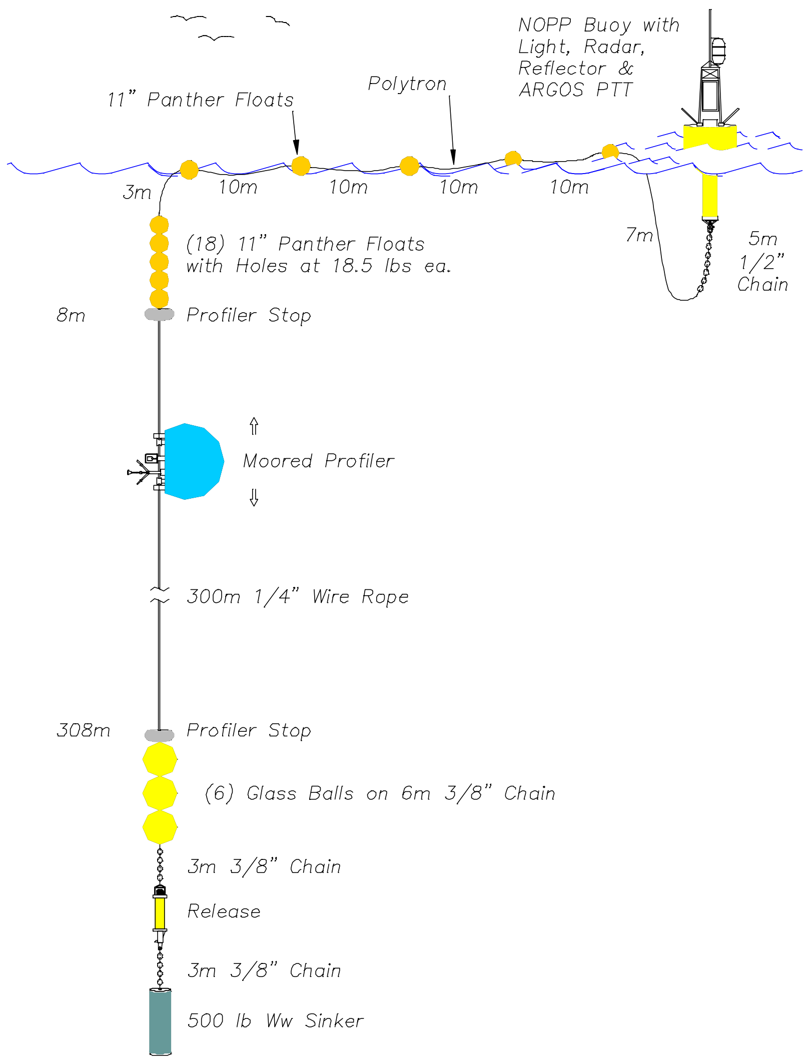

Figure 1. A schematic drawing of the FILIS tether that we will be evaluating in field trials off Bermuda in November 2001. The Moored Profiler instrument will cycle continuously along a 300-m length of plastic-jacketed wire rope suspended below a string of eighteen 11"-diameter plastic floats lying just below the air–sea interface. Stops at the top and bottom of the wire will limit the vertical travel of the Moored Profiler to between approximately 8 and 308 m depth. Using a standard acoustic release, a 500-pound weight will be hung off the bottom of the tether with the goal of keeping the free-drifting tether nearly vertical. Six glass balls will be mounted on a 6-m length of chain just above the release to bring the system into approximate neutral buoyancy. Locating the system during its deployment will be facilitated by a surface buoy fitted with a light, radar reflector, radio beacon and Argos satellite transmitter. The buoy will be attached to the top of the drifting tether with a 50-m length of polytron line. That line will be buoyed every 10 m with a plastic float to hold it at the surface.

TRANSITIONS

None so far.

RELATED PROJECTS

The idea for the FILIS instrument grew out of our LIWI-TWIST experiment, and other recent deep-ocean mixing experiments including our work in the Romance Fracture Zone and the Brazil Basin Tracer Release Experiment.

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