

Long-Term Autonomous Measurement of Ocean Dissipation with EPS-MAPPER

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LONG-TERM GOALS

The long-term goal of this project is to demonstrate the feasibility of making high-quality, autonomous microstructure measurements from an ocean mooring. Successful development of such an instrument would enable researchers to obtain information in situations not currently possible with ship-based systems.

OBJECTIVES

The objective is to develop a new proof of concept instrument called EPS-MAPPER (EPSONDE Moored Autonomous Programmable Profiling Epsilon Recorder). This will enable us to autonomously collect ocean microstructure profiles for periods of several weeks in both weak winds or in severe weather conditions unsuitable for shipboard operations. This profiler merges two well-established instruments, EPSONDE and Seahorse™. The EPSONDE ocean-microstructure technology will be repackaged with modernized electronics and data logging memory and used as the payload for the Seahorse™ moored profiler. Seahorse™ utilizes surface wave energy to move a sensor platform down a mooring wire so that at pre-programmed times it can rise freely to the surface. This package, which works successfully with waves larger than 0.15 m, will be moored in one location and collect as many as 1000 profiles over a period of two weeks. This will provide a very cost-effective approach to obtaining ocean microstructure measurements relative to conventional ship-based operations.

APPROACH

Central to this proposal is the development of a unique, vertically upward profiling moored instrument (EPS-MAPPER) that will provide autonomous scientific-quality microstructure measurements under both weak and strong wind forcing conditions. This development will be accomplished by repackaging the EPSONDE (Oakey, 1988) microstructure instrument to work as the payload of the Seahorse™ mooring system (Fowler et al., 1997; Hamilton et al., 1999). This instrument will typically be moored in water less than 200 m and will be capable of sampling a large percentage of the water column. In the proof of concept version, which is the focus of this project, the EPS-MAPPER will internally record raw data profiles of turbulent temperature and velocity microstructure along with data from a Sea-Bird Electronics (SBE-19plus) CTD. It will be capable of providing data from within a few meters of the ocean surface and to within ~10 m of the seafloor.

The profiling engine of the EPS-MAPPER is the Brooke Ocean Technology Ltd. Seahorse™ wave-powered profiler, which is shown in Figure 1. SeaHorse™ utilizes wave power and a special clamp to power the device down a taut mooring line. When the profiler is at the surface, the clamp is engaged and as the surface buoy rides onto a wave crest, it pulls the cable up through the clamp. As the surface buoy moves down into the wave trough, the one-way cable clamp prevents the cable from moving and the Seahorse™ profiler moves down. The descent rate is 12 to 13 m/min. in moderate seas (order 0.5 m). When SeaHorse™ is at the bottom in the docked position, the programmable controller disengages the clamp with a motor driven cam at a pre-determined interval allowing the profiler to float freely to the surface to its upper docking position. The vertical speed can be easily set within a suitable microstructure profiling range of 0.2 to 0.7 m/s by trimming the Seahorse™ ballast. The only electrical power required by SeaHorse™ is that required for operating a cam motor to engage and disengage the clamp. This proven technology has been used very successfully to obtain 320 profiles of temperature, salinity, turbidity, and chlorophyll over a period of nearly two months at a 70-meter deep site in the Bedford Basin. In October 2000, a similar SeaHorse™ mooring completed an 18-day field deployment on the Scotian Shelf collecting 215 CTD and fluorometer profiles.

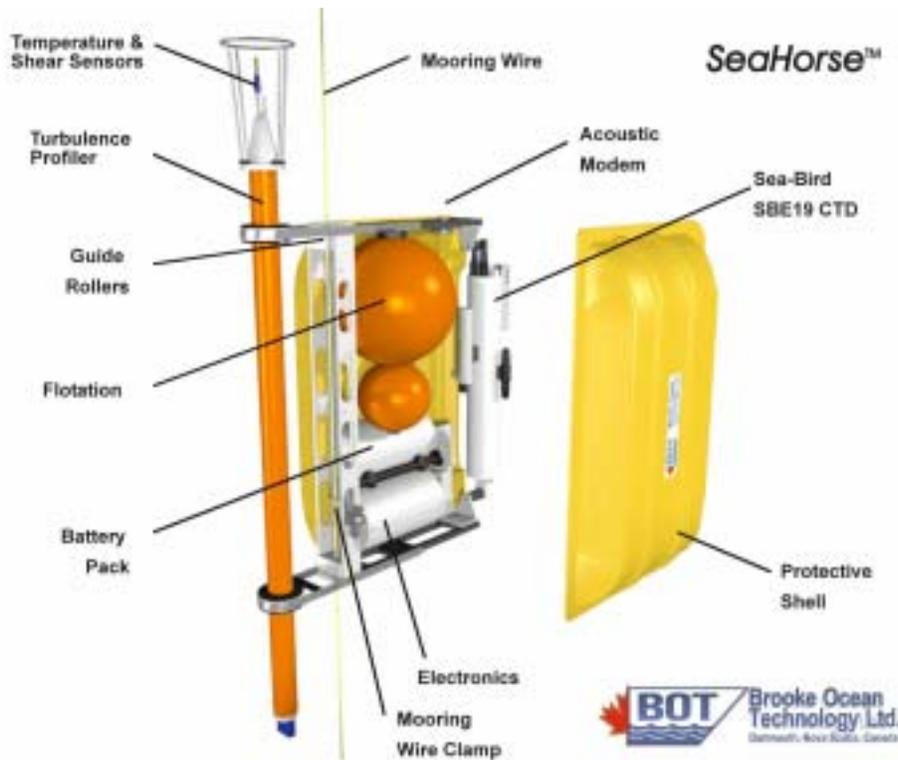


Figure 1: The SeaHorse™ mooring system is shown in an exploded view on the right of the mooring wire. In addition to controlling the movement of the mooring package, this system provides battery power and data acquisition for the payload instruments. In this figure, the payload consists of the EPS-MAPPER microstructure profiler on the left (shown schematically) and a CTD on the right.

The present vertical microstructure profiler EPSONDE will be repackaged as a payload for SeaHorse™. (Figure 1 shows this schematically since the final mounting and re-packaging is not yet complete.) EPSONDE is a low-noise instrument whose characteristics are well understood. It has been deployed as either a tethered free-falling vertical profiler (Oakey, 1988) or as a quasi-horizontal

gliding profiler (Greenan and Oakey, 1999). EPSONDE measures turbulence with two airfoil shear probes, temperature microstructure with a fast thermistor and thin-film platinum thermometer as well as standard CTD measurements. This instrument allows us to estimate the rate of dissipation of turbulent kinetic energy, ϵ , and the rate of dissipation of thermal variance, χ . To repack EPSONDE as the payload for the SeahorseTM profiler will require designing a suitable pressure vehicle and mounting. Analog and digital electronics will be upgraded using low power components and memory capable of storing at least 1000 raw data microstructure profiles from 50 meters depth to the surface. The output of a standard Sea-Bird Electronics (SBE-19) CTD will be logged with the microstructure data. In addition, we plan to use an acoustic Doppler velocimeter to measure velocity shear in the water column. This would allow us to calculate profiles of gradient Richardson Number.

EPS-MAPPER, the synthesis of EPSONDE and SeaHorseTM, will provide many advantages over current profiling techniques for measurement of turbulence from a ship. Under moderate winds, autonomous profiling is far more economic than ship-based measurements and profiles will be made closer to the surface than present techniques that have difficulty resolving the top 5 to 8 meters. The EPS-MAPPER profiler is designed to provide several profiles per hour depending on various parameters such as the surface wave field and the depth of the profiles. The EPS-MAPPER profiler will allow measurements in high wind speeds not possible by current techniques. We believe that we can obtain at least three profiles per hour from 50 meters depth in waves as low as 0.5 m that would result in 1000 profiles in a two-week deployment.

WORK COMPLETED

The design and fabrication of the EPS-MAPPER electronics will be completed this fall. The output of the 16 analog channels will be converted to digital signals, processed and logged to a CompactFlash disk. The system will be controlled with Persistor Instruments CF1 microprocessor which, in turn, will be interfaced with the microprocessor on the SeaHorseTM to allow synchronization of the data collected with the Sea-Bird CTD.

A key area of concern is the mechanical mounting of the EPS-MAPPER on SeaHorseTM. The shear probes are very sensitive to mechanical vibrations and great care must be taken to isolate these sensors from noise generated by the mooring system. Two different mounts are being designed and will be tested on a mooring in Bedford Basin this fall.

RESULTS

IMPACT/APPLICATIONS

The potential impact for this novel instrument design is that it would provide a new way of making ocean turbulence measurements with potential for applications that are not feasible using the current ship-based systems. This would also be a much more economical method of making such measurements.

TRANSITIONS

RELATED PROJECTS

REFERENCES

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