Aircraft-Launched High-Resolution Pressure Pod

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LONG-TERM GOALS

The long-term goal of this program is to understand the physics of small-scale oceanic processes including internal waves, hydraulics, turbulence and microstructure that act to perturb and control the circulation in coastal oceans and, in doing so, affect the propagation of sound and light. Ongoing studies within the **Ocean Mixing Group** at OSU emphasize observations, interaction with turbulence modelers and an aggressive program of sensor / instrumentation development and integration.

OBJECTIVES

The objective of this proposal is to construct a rugged, high-resolution pressure pod that can be launched from an aircraft. This will sink to the seafloor for periods up to 3 months. An acoustic release will permit recovery and surface reporting of all data.

APPROACH

We have modified existing electronics hardware to count Paroscientific pressure and temperature frequencies and to integrate GPS receiver and Iridium and wireless transceivers.

WORK COMPLETED

An inertial motion package has been installed. The purpose is to measure directly the impacts on the body when the parachute opens and when the body hits the water. Preliminary tests were conducted by dropping a mockup off the Yaquina Bay bridge (46 m bridge height). Tests from aircraft were conducted in September 2009. Seafloor deployment tests in Puget Sound were conducted in March 2009 and repeated in December 2009 and June 2010.

We have incorporated an acoustic transducer into the end cap. The transducer acts to trigger the release sequence. Several units have undergone extensive testing in our lab and have been successfully deployed (8 units) in Puget Sound (Dec 2009), Oregon’s shelf (June 2010) and will be used in Puget Sound in Oct 2010.

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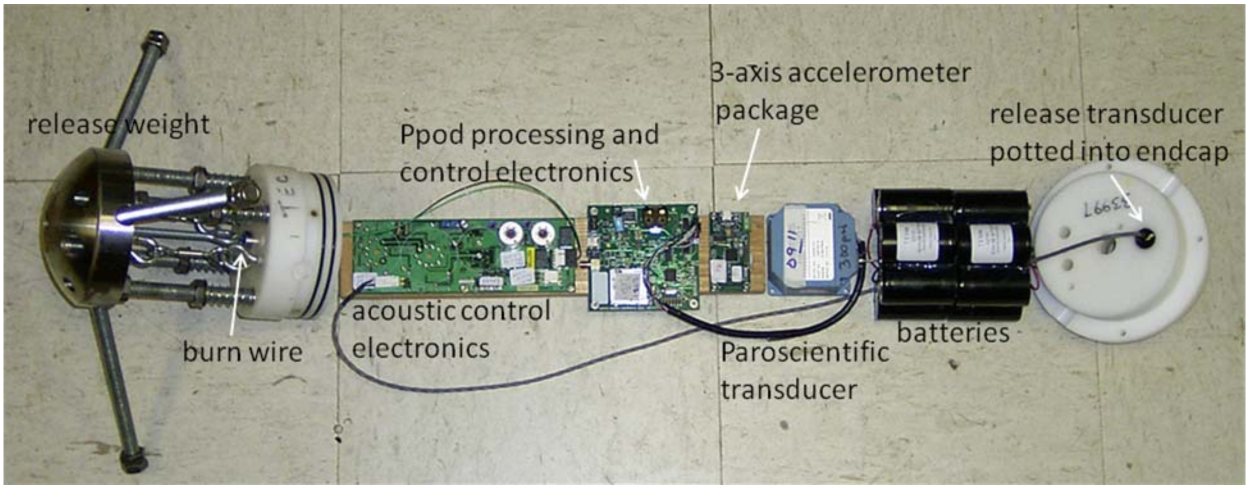

Figure 1 – Air Ppod as configured for helicopter launch. Three air launches survived surface impacts of 22-45 g's, followed by bottom impacts of about 3g's in 10 m of water.

Ppods were deployed in Massachusetts Bay as part of a separate project in September 2008 and July 2009 (Jim Lerczak and Kipp Shearman, both from OSU). Data have been shared with Lerczak and Shearman and used by us to test nonlinear internal wave detection algorithms and to begin to evaluate the three-dimensionality of nonlinear internal wave fronts.

RESULTS

A nonlinear internal wave antenna constructed of 14 seafloor pressure sensors was deployed in Massachusetts Bay in July 2009 as part of a larger experiment to look at the shoaling nature of the waves there (Lerczak/Shearman). Examples of the signature of a single wave at 8 locations in the array are shown in Fig. 2. Vector wave speeds were computed at centroids of seafloor pressure sensor triads. These show the shape and evolution of wave groups as they progress westward into shallow water. They indicate a remarkably small cross-frontal expanse of the waves in this section of the Bay. The observed three-dimensionality is being compared to shipboard radar and satellite observations as well as model results of nonlinear internal waves from the region.

A re-evaluation of seafloor pressure measurements from New Jersey's shelf during SW06 has led to development of an algorithm to achieve real-time detection of moderate waves, > 250 Pa (Fig. 3). These waves are significantly smaller than those deemed dangerous for offshore structures which require warnings for large waves. The rationale and algorithm are reported by Stoeber and Moum (2010).

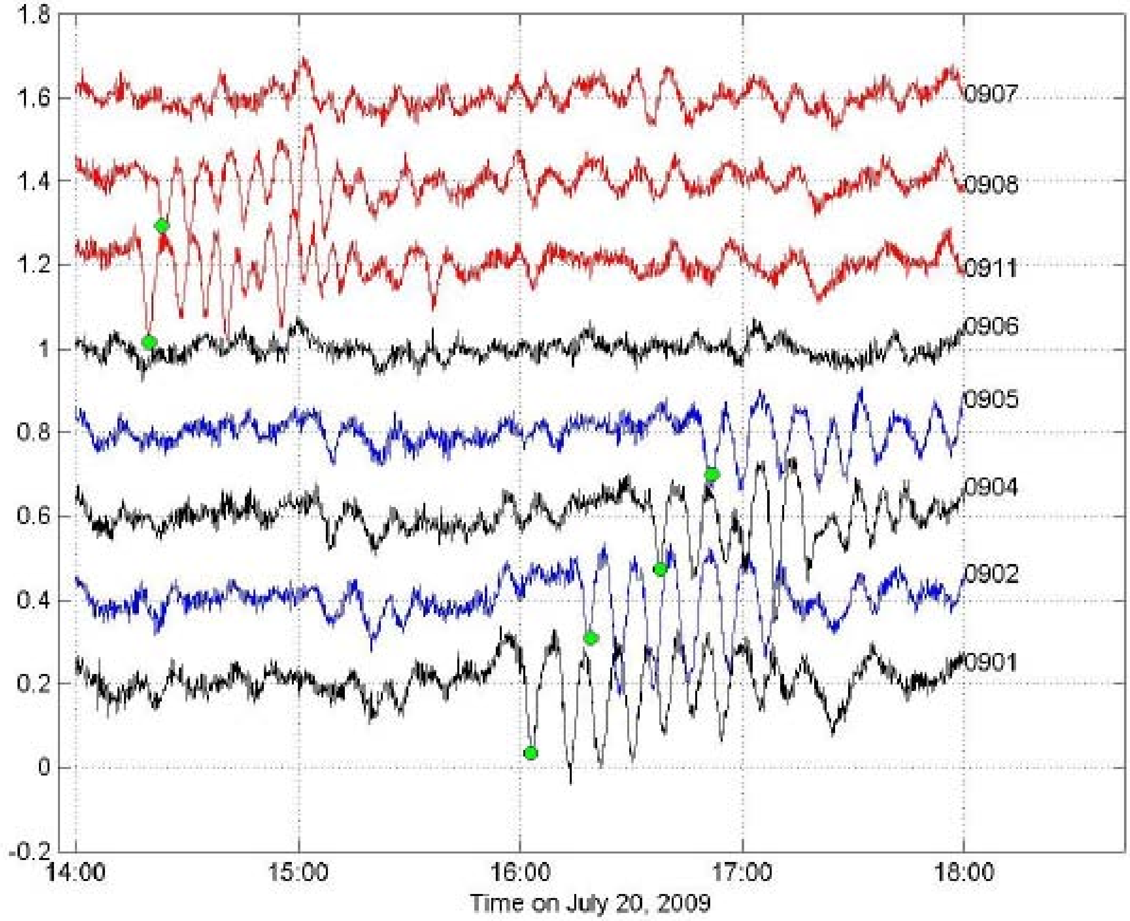

Figure 2 – Detection of nonlinear internal waves at various locations in Mass. Bay. Leading waves that are clearly detected are noted by the green dots. The finite extent of the wave fronts is indicated by the lack of signal at northernmost locations (0906, 0907).

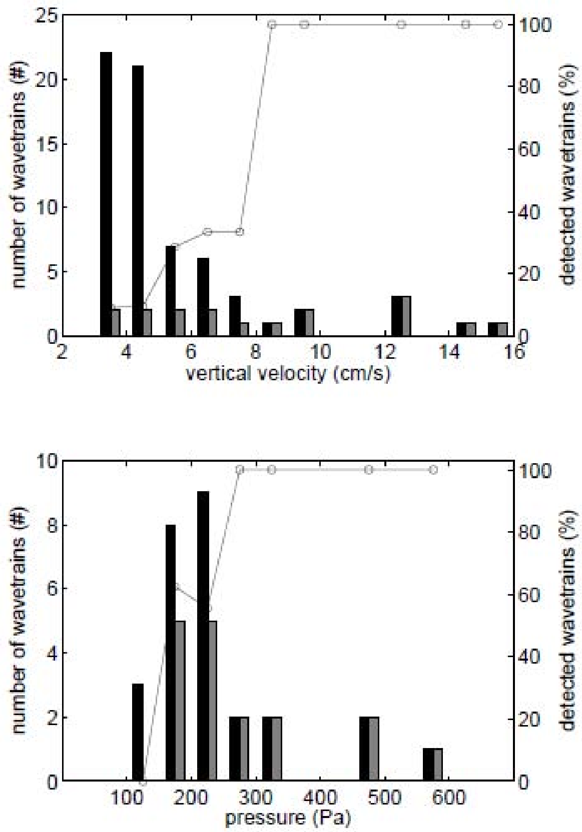

Figure 3 – Number of wavetrains detected in vertical velocity (top, black) and in pressure (bottom, black) and that have a counterpart in the other signal (grey), i.e. that are successfully identified. The black line shows the number of successfully detected wavetrains in percent.100% success is achieved for waves with pressure amplitudes > 250 Pa. These correspond to moderate continental shelf waves (roughly 10 m amplitude).

IMPACT/APPLICATION

The objective of this project is to develop an easy-to-deploy and inexpensive means to outfit continental shelves with seafloor-based nonlinear internal wave antennae. Successful demonstrations have been made over the past year in several locations. These will help in defining internal wave climates on continental shelves.

TRANSITIONS

Several of our seafloor pressure sensors will be loaned to Naval Research Lab personnel (Wijesekera, Teague, Jarosz) for use in the MORT (Mixing Over Rough Topography) experiment in the Gulf of Mexico in 2011. These will be used to measure the pressure drop across bathymetric obstacles to flows above. From these measurements the topographic form drag will be estimated.

RELATED PROJECTS

Ppods have and are being used in related projects to help us gain experience with interpreting the measurement over a broad range of conditions. These have included measurements over Stonewall Bank (June 2008, May 2009, June 2010; Moum / Nash / MacCready / Skyllingstad), in Massachusetts Bay (July – October 2008, and July 2009; Lerczak / Shearman) and in Puget Sound (March 2009, December 2009, March 2010, October 2010).

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PUBLICATIONS

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