Ocean Bottom Seismometer Augmentation of the NPAL 2010-2011 Philippine Sea Experiment

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LONG-TERM GOALS

This project addresses the coherence and depth dependence of deep-water ambient noise and signals. Seafloor signals will be studied in the band from 50-400Hz and seafloor ambient noise will be studied in the band from 0.03 - 80Hz. On NPAL04 we observed a new class of arrivals in long-range ocean acoustic propagation that we call Deep Seafloor Arrivals (DSAs) because they are the dominant arrivals on ocean bottom seismometers (Mercer *et al.*, 2009; Stephen *et al.*, 2009; Stephen *et al.*, 2008). They either were undetected or very weak on the deepest DVLA hydrophone located near the conjugate depth about 750m above the seafloor. It appears that at least part of the path for DSAs is through or on the seafloor perhaps as an interface wave. We will do a similar experiment in the Philippine Sea.

OBJECTIVES

The objective here is to understand the relationship between seafloor pressure and seafloor particle motion for both ambient noise and short- and long-range signals. What is the relationship between the seismic (ground motion) noise on the seafloor and the acoustic noise in the water column? What governs the trade-offs in contributions from local and distant storms and in contributions from local and distant shipping? How effective is seafloor bathymetry at stripping distant shipping noise from the ambient noise field?

APPROACH

This project will quantitatively compare the signal and noise levels in the Philippine Sea in the 50-400Hz band on the hydrophones and geophones at the seafloor to the hydrophones suspended up to 1 kilometer above the seafloor, for ranges from near zero to 250km. We will also study seafloor ambient noise in the Philippine Sea in the band from 0.03 - 80Hz and compare it to other deep-water sites in the Pacific Ocean. Specific questions to be addressed include: i) Is there evidence for Deep Seafloor Arrivals in the Philippine Sea (water depths around 5500m) that are similar to the ones observed on NPAL04 (water depths around 5000m)? ii) What is the frequency dependence of the deep arrival structure from 50 - 400Hz? iii) What is the range dependence of the deep arrival structure out to 250km? iv) What is the azimuth dependence of the deep arrival structure? v) What are the relative SNRs of arrivals on vertical and horizontal geophones, co-located seafloor hydrophones and moored hydrophones (from 20m to 1000m off the bottom - 15 hydrophones at about 60m separation)? vi) What are the phase relationships between pressure and vertical and horizontal particle motion for deep seafloor arrivals and ambient noise? vii) What is the relationship between the observed deep arrival structure and the PE predicted arrival structure? viii) How far above the seafloor does the Deep Seafloor Arrival structure extend?

The measurements will be made using J15-3s with a bandwidth from 50 to 400Hz, depths down to 100m, ranges to 250km and a variety of azimuths based on the known bathymetry. We will carry out a two-cruise program at the end of the 2010-2011 Philippine Sea experiment:

i) Deploy a deep section of DVLA at the Philippine Sea DVLA site during the recovery cruise for the main Philippine Sea DVLA. The deep DVLA will consist of 15 hydrophones spanning from just above the seafloor (about 40m) to the conjugate depth (about 4500m). We will add two days to the existing PhilSea10 recovery cruise in Spring 2011 - one day to deploy the deep DVLA plus one day for contingencies.

ii) A 26 day cruise to deploy six OBSs at the base of the deep DVLA and carry out a 14day shooting program using J15-3s (similar to the July 2010 shooting program). Each OBS will have a three-component seismometer and hydrophone or differential pressure gauge. Four OBSs will be L-CHEAPOS sampling at 1000sps suitable for the frequency band from 1-400Hz, and two OBSs will be broadband instruments sampling at 200sps and suitable for the frequency band from 0.03 to 80Hz. The L-CHEAPO short period OBSs are pretty much the same units we had in 2004. Some critical differences are that the 2011 OBSs will acquire three components of particle motion plus acoustic pressure and they will sample at 1000sps. (The 2004 OBSs had only a vertical geophone and hydrophone and sampled at 500sps.) We do not expect that the system noise levels for the geophone or hydrophone channels will be significantly different from the 2004 experiment which was system noise limited (Stephen *et al.*, 2008). The broadband OBSs will provide seafloor ambient noise data for comparison with other deep-water, broadband data sets in the Pacific such as the Hawaii-2 Observatory (H2O) (Duennebier *et al.*, 2002; Stephen *et al.*, 2006) and the Ocean Seismic Network Pilot Experiment (OSNPE) (Stephen *et al.*, 2003).

The shooting program will consist of a variety of transmission formats with center frequencies from 75 to 300Hz. The receptions will be time compressed using matched field processing to yield impulsive arrivals, that can be studied for multi-path effects and signal-to-noise ratios. For at least one azimuth we will have no bathymetric blockage along a line out to 250km, similar to NPAL04, where we can look for DSA's in a clean wave guide. At least one other path will have bathymetric blockage for comparison. Many radial lines and circles at half and one CZ ranges will be shot to study the azimuth dependence of the bottom interaction within one CZ.

WORK COMPLETED

This project has a start date of September 1, 2010 and our work is just beginning.

RESULTS

No results yet.

IMPACT/APPLICATIONS

Clearly the ability of Navy systems to detect and identify ships and submarines by acoustic techniques will depend on at least the following factors: i) the system noise of sensors used to detect the acoustic field, ii) the true field noise for a given sensor type and location, and iii) accurate knowledge of how sound travels in the ocean including bottom interaction if necessary. The observation of deep seafloor arrivals on NPAL04 showed that there is a significant bottom path for coherent sound propagation that was previously unrecognized and is still poorly understood. If this path is as ubiquitous as we expect it will have significant consequences for the performance of any ASW system that uses seafloor receivers, for predictions of long- and short-range propagation to seafloor receivers, and for models of near seafloor ambient noise in the deep ocean.

TRANSITIONS

None yet

RELATED PROJECTS

LOAPEX - ONR Award Number N00014-1403-1-0181

SPICEX - ONR Award Number N00014-03-1-0182

PhilSea09 and PhilSea10 - ONR Award Number N00014-08-1-0840

Bottom Interaction in Ocean Acoustic Propagation - ONR Award Number: N00014-10-1-0510

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PUBLICATIONS

None

HONORS/AWARDS/PRIZES

Ralph Stephen, WHOI, Edward W. and Betty J. Scripps Chair for Excellence in Oceanography, WHOI.