Quarterly Progress Report

Technical and Financial

Deep Water Ocean Acoustics
Award No.: N00014-14-C-0172

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Notices:

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Technical Progress Report

1. Introduction

The goal of this research is to increase our understanding of the impact of the ocean and seafloor environmental variability on deep-water (long-range) ocean acoustic propagation and to develop methodologies for including this in acoustic models. Experimental analysis is combined with model development to isolate specific physics and improve our understanding. During the past few years, the physics effects studied have been three-dimensional propagation on global scales, deep water ambient noise, under-ice scattering, bathymetric diffraction and the application of the ocean acoustic Parabolic Equation to infrasound.

2. Tasks

a. Task 1: Basin Scale Acoustic Propagation and CTBTO Data Analysis

In this quarter Dr. Heaney visited Professor Yamada and Dr's Mario Zampolli and Georgios Haralabus at the UN Comprehensive Test Ban Treaty Organization in Vienna. The Yamada measurements, of large shots used as seismic sources off the coast of Japan received at the CTBTO HA03 station in Juan Fernandez Chile, are a treasure trove of long-range low frequency acoustic propagation. In conferring with the CTBTO scientists, it has become clear that acoustic out of plane scattering (forward reflections, refraction and diffraction) are significant observable effects. Dr. Heaney set up a broadband PE run in 3D to a range of 16700 km. Initially this was done for frequencies of 3-4 Hz for run-time considerations.

The technical results of the interactions are being collected into a Journal article. Some of the findings are summarized here. The move-out arrivals of the 100 shots on H03N1 are shown in Figure 1.

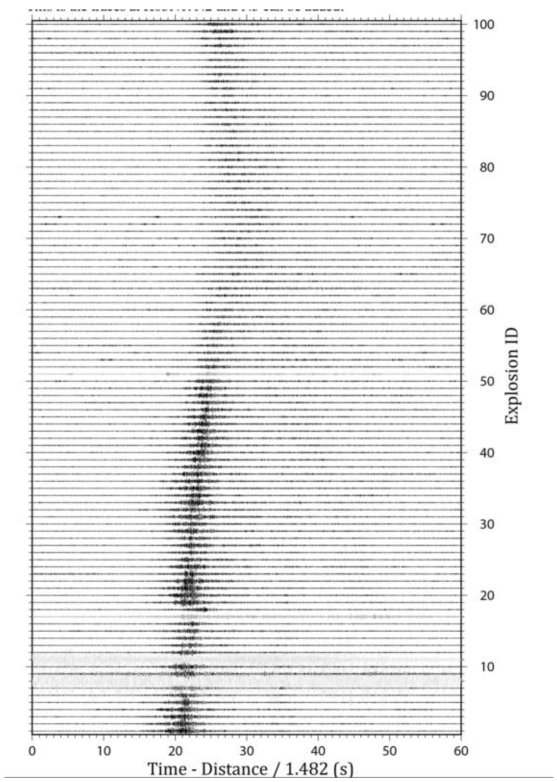

Figure 1. Signals from 100 explosions   high amplitudes and fast arrivals [1-50], low amplitude and slow arrivals [51-100]

A high energy arrival (20) is shown in Figure 2. Note the significant Signal-to-Noise ratio, the modal dispersion below 10Hz, the slight evidence of related arrivals at 38 and 48 s. The dominant frequency range of energy is clearly 10-40Hz. Unfortunately, this is higher than the band used for propagation modeling done in June. This will be addressed by pushing the PE model up in frequency during the month of July.

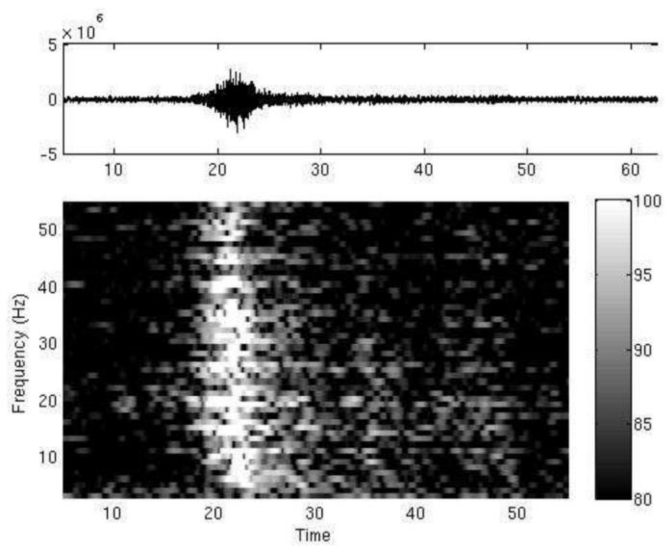

Figure 2. Time series (top) and spectrogram of shot 20.

The 3D PE was run, using reciprocity, from Juan Fernandez, Chile to each shot location off the coast of Japan. Peregrine has an option where the 3D code can be computed along a tube centered on the geodesic path. Initially this computational tube was set to 300km, as it was expected that the energy received in the shadow of Hawaii would refract around small islands and fill in the shadow. This turned out not to be the case. The energy observed in the shadow of the Hawaiian Islands is refracted from Midway, and thus the width of the computational tube must be set to 1000 km. The 4Hz run was performed and is compared with the observations in Figure 3.

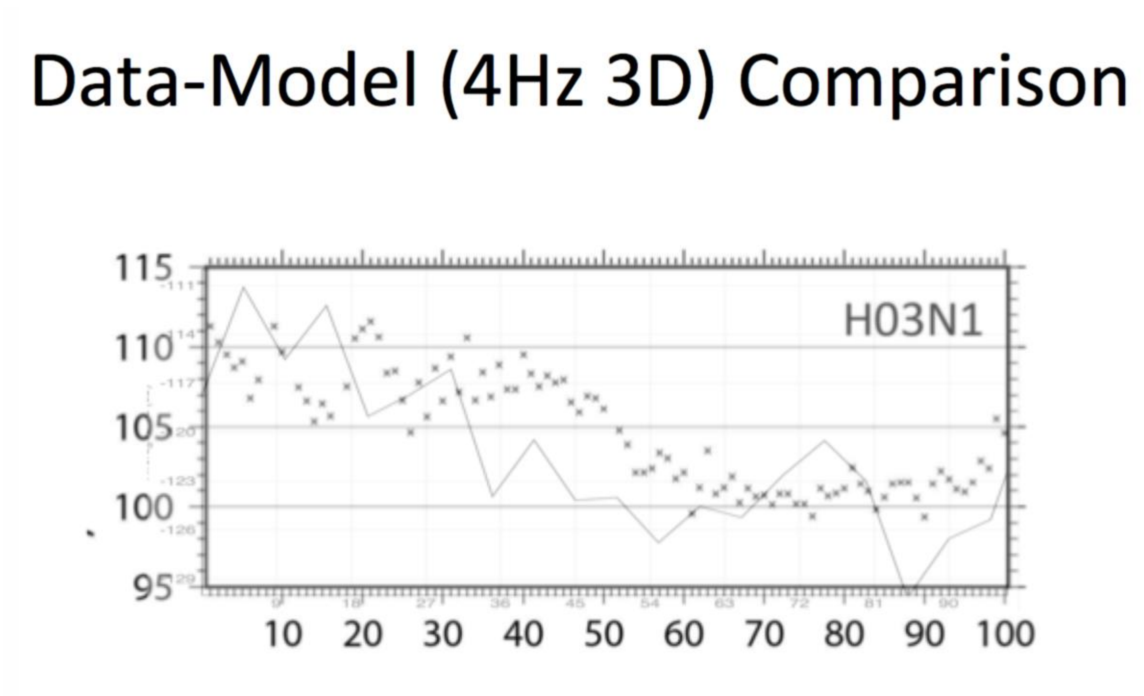

Figure 3. Received Sound Exposure Level (integrated energy over 5 s) for the data (*) and the 3D Peregrine Model (line) run at 4Hz.

The source level in this overlay is a free parameter (but is estimated to be ~215 dB) re $1uPa^2/m^2$). This agreement is exceptional. It shows the dip in received level by about 10 dB from shots 1-30 and shots 60-80. Note that the 2D computation has a dip of ~100 dB. The 3D computation with a 300 km computational tube had a dip of ~ 30 dB.

The broadband PE was run from 3-5Hz for each shot location. The ray-tube was set to 300 km, which is known to be deficient. Yet, the preliminary results are quite promising. The PE-data comparisons are shown in Figure 5, where the PE has been run for every 10^{th} shot.

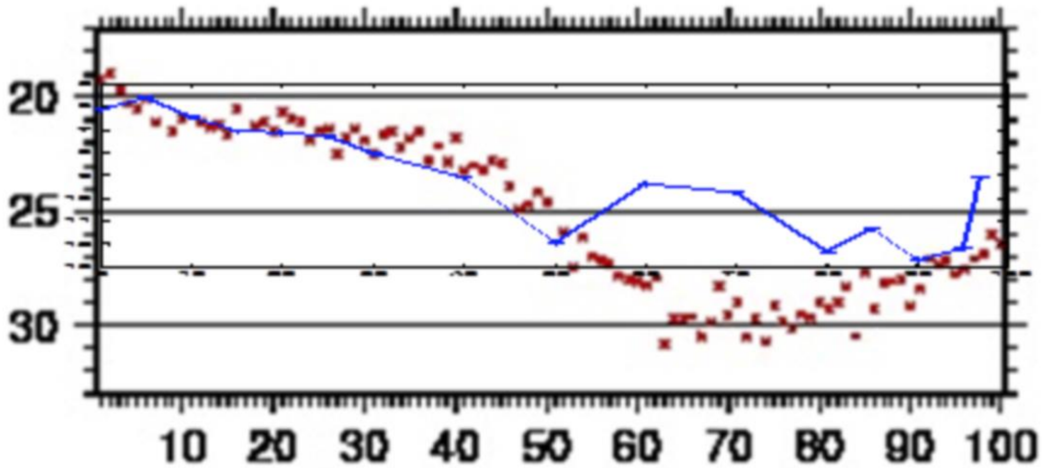

Figure 4. Arrival time (center of mass) of the measurements (*) and the model results (lines) for the 3D Peregrine Model (line) run from 3-5 Hz.

b. Task 2: NPAL PhilSeal0 Data Analysis and Matched Field Processing

No work was done on Task 2 during this period of performance.

3. Future Plans

The 3D PE model is being computed from 5-20Hz for the incoherent energy level and from 5-10 (hopefully) for the broadband time-series. These results will be merged with the data analysis of Yamada into a journal paper, likely the Journal of the Acoustical Society of America.

4. Publications and Peer Interactions

Dr. Heaney met with Prof. Tomoaki Yamada (University of Tokyo), Dr. Mario Zampoli and Dr. Georgios Haralabus at the CTBTO offices in Vienna.

Revisions where made to "Bathymetric diffraction of basin-scale hydroacoustic signals" by Kevin D. Heaney, Richard L. Campbell and Mark Prior, and it was re-submitted to Journal of the Acoustical Society of America on March 20, 2016.

5. Financial Summary

OASIS, INC.

JOB STATUS REPORT **6/30/2016**

1172 DEEP WATER ACOUSTICS **N00014-114-C-0172**

POP: 9/27/13-12/30/16

CONTRACT VALUE	Cost	Fee	Total
Contract Value	$368,935	$27,048	$395,983
Funding Value:	**$368,935**	**$27,048**	**$395,983**
Remaining to Fund:	$0	$0	$0

CUMULATIVE SPENDING WITH COMMITMENTS

	DIRECT	OH	MH	TOTL COST	FEE	**TOTAL**
ACTUAL						
OASIS	$177,320	$133,895	$3,734.13	$314,949	$23,621	**$338,570**
COMMITTED						
	$0	$0	$0	$0	$0	**$0**
	$177,320	$133,895	$3,734	$314,949	$23,621	**$338,570**
TOTAL REMAINING TO SPEND:						**$57,413**