Hydroacoustic Studies Using HydroCAM – Station-centric Integration of Models and Observations

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1. Summary of Activities

BBN's work during the fourth quarter of 2003 was focused on delivering HydroCAM 4.1, data collection and analysis, and procuring high-resolution bathymetric data.

Despite our optimism at finding a contact in the Naval Oceanographic Office to help us with high-resolution bathymetry, the data do not exist in the security classification and resolution that we require. We are investigating other sources of high-resolution bathymetry data.

HydroCAM 4.1, which includes the ability to make blockage predictions using varying resolution bathymetric data, was delivered to DOE in late December 2003/early January 2004. BBN also delivered its ground truth database of hydroacoustic events in the Indian Ocean for 2001-2003.

2. Introduction

The current contract's period of performance began on September 4, 2002. BBN is now on its second increment of funding which was intended to cover BBN's work through fiscal year 2003.

This contract's research is intended to extend the capability of BBN's Hydroacoustic Coverage Assessment Model (HydroCAM). Specifically, the effort is designed to improve HydroCAM's database and modeling capabilities with respect to hydroacoustic blockage. In this phase BBN is undertaking three tasks. First, BBN is investigating blockage by analyzing events in the Indian Ocean that are recorded at the International Monitoring System (IMS) stations at Diego Garcia and Cape Leeuwin. Second, BBN will attempt to improve HydroCAM's blockage modeling capability by integrating high-resolution bathymetry into HydroCAM near IMS stations.

The third task in this contract is a support-oriented one. BBN is tasked to support the HydroCAM and modeling needs of DOE and AFTAC. Lawrence Livermore National Laboratory (LLNL) and AFTAC are the two primary users of HydroCAM. In the past BBN has also supported them by performing event-driven data analysis and modeling tasks. Therefore, BBN expends significant effort maintaining the HydroCAM software and addressing any issues/needs that our contacts at DOE and AFTAC might have.

What follows is a complete summary of BBN activities on these tasks from October 2003 – December 2003.

3. Software Development and Support

3.1. High-Resolution Bathymetry Search

In our last report, we were very optimistic about a new contact at the Naval Oceanographic office that was willing to help us with high-resolution bathymetry requests. We submitted a formal request through Leslie Casey for <1minute resolution bathymetry near the Indian

Ocean IMS stations at Diego Garcia, Cape Leeuwin, and Crozet. Unfortunately, the data simply do not exist at that resolution in the Navy's data that is classified SECRET.

Our initial strategy for improving HydroCAM's blockage predictions was to use high-resolution bathymetry near the IMS stations coupled with observations from the IMS data to refine the blockage calculation. Per a discussion with Phil Harben, BBN will exercise some of its contacts outside of the US Navy in a last effort to find high-resolution bathymetry near the Indian Ocean IMS stations. BBN will document the results of the entire bathymetry search. In addition, BBN will attempt to identify contingency plans (i.e., diffraction/scattering models, high-resolution bathy near other stations, etc.) should the search end unsuccessfully.

3.2.HydroCAM 4.1

As stated in previous reports, HydroCAM 4.1 includes the ability to calculate paths using very high-resolution bathymetry near a receiving station while using lower resolution global bathymetry for the rest of the ocean. We hope that this will improve our ability to predict hydroacoustic blockage.

BBN has integrated a high-resolution bathymetry dataset at Wake Island into HydroCAM's GlobeRay model. HydroCAM can use this dataset in conjunction with a larger, lower-resolution, global dataset (i.e., ETOPO5) to calculate acoustic propagation and blockage at the future Wake Island hydrophone installation. The models and interfaces have been revised to handle two bathymetry datasets of different resolution, so integration of new data near other hydrophone stations should be simple. However, since we have no acoustic data at Wake to use to validate our model improvements, it is difficult to assess the value of these improvements with respect to hydroacoustic blockage prediction.

HydroCAM 4.1 was released to DOE in late December 2003/early January 2004. We anticipate delivering HydroCAM 4.1 to AFTAC in early 2004.

4. Data Collection and Analysis

Data collection efforts continued in the fourth quarter. BBN monitors the Indian Ocean for earthquakes and other events of interest that might be recorded at the IMS stations at Diego Garcia and Cape Leeuwin.

BBN delivered a database of over 130 hydroacoustic events in the Indian Ocean to DOE in the fourth quarter. These data span dates from 2001-2003, and are recorded on the hydrophone stations in the Indian Ocean. These data should be valuable in studies of reflection, discrimination, blockage, etc.

5. POA&M for Q1 2004

BBN's POA&M for the first quarter of 2004 is focused on the 2004 SOW that was approved as a condition of our 2004 funding increment. This quarter will be focused on:

- A final effort to identify and obtain high-resolution bathymetry near the Indian Ocean IMS stations;
- Documentation of the results of our bathymetry search;
An initial evaluation of diffraction and scattering models to improve HydroCAM's blockage prediction capability in the absence of high-resolution bathymetry;
- Contact AFTAC regarding their operational needs and HydroCAM. Coordinate a 2004 HydroCAM support/training visit to AFTAC.

Task	January				February				March			
Project Management												
Bathymetry Research												
Bathymetry Search												
Document Bathymetry Search												
Investigate Diffraction Models												
Data Collection and Analysis												
Continued Data Collection												
Data-based blockage study												
Software Support												
Coordinate AFTAC support												
Software Maintenance												

5.1. Labor Budget

The first \$100K of BBN's 2004 funding has arrived. The current plan is for Dr. Pulli and Mr. Upton to support the contract at approximately 20 hours/month. In addition, Dr. Joydeep Bhattacharyya (formerly of CMR) will be joining the program at a similar level. When the remaining \$50K of funding arrives, we will reevaluate our labor budget.

5.2. Risks

The biggest risk in our current effort is that our search for high-resolution bathymetry near the Indian Ocean IMS stations will end unsuccessfully. As stated above, we are exploring contingency plans with Phil Harben and others if the data do not exist.