A National Oceanographic Partnership Program Award

Completion and Field Demonstration of a Portable Coastal Observatory

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http://dunkle.whoi.edu/webdata/LCT-Buoy/
http://quashnet.er.usgs.gov/lct/

Long Term Goals

The goal of this project is to complete the development and field demonstration of an affordable, easy to use technology for the real time collection and dissemination of data from instruments deployed in the coastal ocean. The observing system that has been developed consists of four elements: a low-cost acoustic data link that transfers data from instruments on the bottom or in the water column to a nearby surface buoy, a lightweight, easy to deploy surface buoy (and mooring), a radio modem to send data to shore, and an internet-based automatic data distribution and display system. The project is being conducted cooperatively with the U.S. Geological Survey, Woods Hole Oceanographic Institution, RD Instruments, the Massachusetts Water Resources Authority, and the U.S. Coast Guard.

Objectives

This project is a follow-on to the project titled Low Cost Modular Telemetry for Coastal Time-Series Data, which resulted in the development and demonstration of an acoustically linked coastal data collection system. The system was deployed for four extended periods and most elements performed very well, however, the acoustic link was not as robust as expected. The objectives of the present project are to fully implement the new low cost transmitter hardware and software to improve the acoustic performance, to demonstrate the system with multiple subsurface instruments, and to improve the automated data distribution system.

Approach

The Portable Coastal Observatory concept provides a cost effective means to monitor the coastal ocean on a variety of space and time scales and distribute the data collected over the Internet in near real time. The approach uses low cost acoustic links to connect sensors to surface buoys that are equipped with radio links to transfer the data to shore. This approach avoids the need to lay fixed cables on the seabed to get real-time data and has the added feature that the sensors and RF buoys are easily moved to new locations. The receive system in the surface buoy is capable

of collecting and forwarding data from many independent sensors within the acoustic network. When the data is received by the radio link on shore, it is immediately forwarded to a website that is available to the public.

Work Completed

We have completed the development of the low cost acoustic transmitters and the acoustic signaling protocols have been modified to improve their performance in the shallow water, high multipath environment found in the coastal ocean. As a result of these improvements, the acoustic link is now operating with a packet error rate of less than 0.1% under all weather and water conditions observed to date. The real time data from the Scituate site in Mass Bay can be viewed at http://quashnet.er.usgs.gov/lct/.

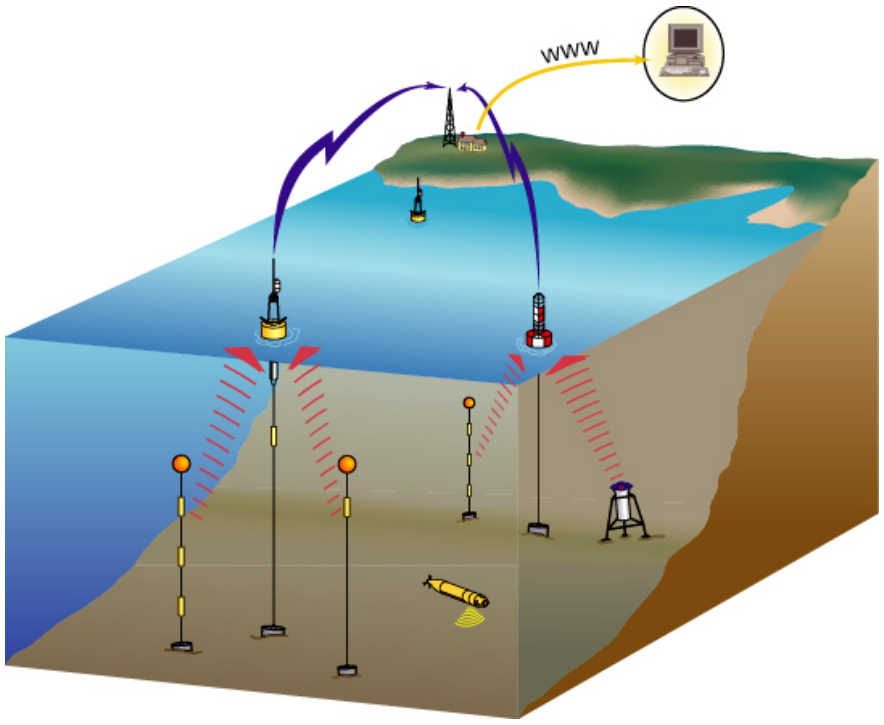

Figure 1. Concept drawing of the Portable Coastal Observatory illustrating the acoustic and RF data links from sea to shore and the final connection to the Internet.

A second site in Mass Bay has been instrumented using an existing Coast Guard buoy as a platform of opportunity. We added an Iridium transceiver to this site to improve the reliability of the RF link and this has worked very well. However, we are still experiencing difficulty with the acoustic link when the receive hydrophones are deployed just below the large Coast Guard buoy. We will be comparing several alternative methods for deploying the receive hydrophones to see if we can achieve the kind of performance that we have seen at the small buoy at Scituate.

Results

- The acoustically linked coastal telemetry concept is being demonstrated in prototype form in Massachusetts Bay. The moored surface buoys and other hardware have proven to be robust, low cost and easy to use.

- Design and construction of the low-cost acoustic transmitter (LCT) has been completed. Field tests with the new hardware and modified acoustic protocols have proven both the reliability of the hardware and the robustness of the acoustic data link. Acoustic error rates have been negligible with the modified equipment at the Scituate site (see Figure 2).

- The telemetry system on the standalone research buoy at the Scituate site has been operating reliably for many months (see Figure 2). We plan to add a Seabird CTD to the sensor array at this site.
- The telemetry system designed for the USCG Boston Approach Buoy has not operated reliably to date. We have added an Iridium RF link because the site is near the limit for the low power, line of sight radio link to the Marshfield Tower. We are in the process of updating the acoustic equipment on the buoy.
- A real-time data processing and display capability has been developed and is available via the project website.

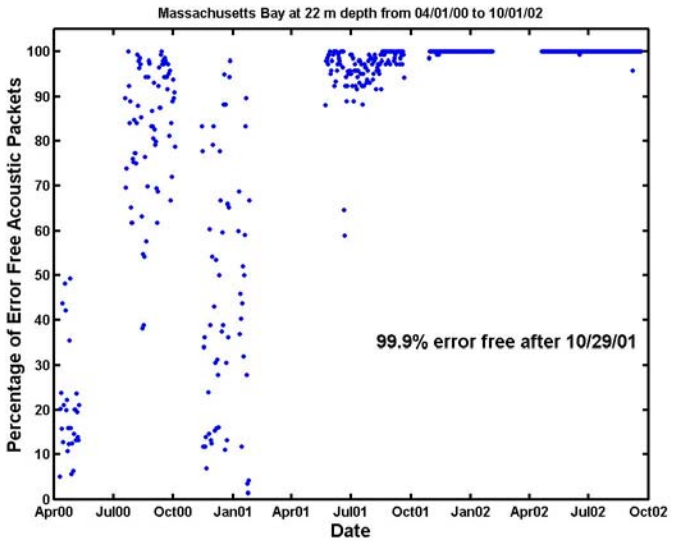

Figure 2. Acoustic error rates observed over 2 ½ years at the Scituate site in Mass Bay

Impact and Applications

The development of the low cost Portable Coastal Observatory system has the potential to provide observations from distributed arrays with multiple sensors on a wide variety of spatial scales. Such observations are needed to resolve key processes, for ocean prediction, to aid in developing optimal sampling strategies (particularly for coupled physical and biological studies), and for long-term monitoring. The technology developed on this project is an enabling technology for low cost coastal observatories and relocatable coastal observatories.

Economic Development

The low cost acoustic telemetry hardware and software used as a key element in the Portable Coastal Observatory concept was not developed as part of this project, but it has been improved based on results of the project. By demonstrating the reliability and low error rates that are achievable in the difficult shallow water acoustic channel, we have made the acoustic modems used on this project more desirable to commercial manufacturers. We are presently pursuing licensing agreements with several oceanographic equipment manufacturers for rights to the acoustic modems developed at WHOI.

Quality of Life

The Portable Coastal Observatory system is designed to provide an easy to use, low cost technology for monitoring the coastal ocean in real time. Thus, it has the potential to provide scientific users and resource managers with the data that they need to make better decisions without requiring expensive cabled sensor systems to be installed everywhere that sensors are needed. This technology could have significant impacts on Quality of Life issues because better decisions can be made with better and more timely environmental data.

Science Education and Communication

We have developed a publicly accessible website to disseminate the real time data that are being collected. As the Portable Coastal Observatory concept is broadened, this kind of real time access will be an important means of outreach and communication with the general public and with marine science educators and their students.

Transitions

National Security

Three buoy and telemetry systems were delivered to NAVOCEANO based on the systems developed under this project. Two of these systems were deployed in the Gulf of Mexico as part of the Northern Gulf of Mexico Littoral Initiative program [1]. While the NGLI program was not primarily a National Security program, NAVOCEANO is evaluating these buoy and telemetry systems for use in other areas that are of interest to the DOD.

Economic Development

1. Similar acoustic technology is being utilized on the ULTRAMOOR long-term mooring project, which is an NSF program being conducted at WHOI to develop a 5-year deep ocean current meter mooring with periodic data telemetry [2]. We are talking with various current meter manufacturers about the possibility of integrating the acoustic modems that were demonstrated on the NOPP project into their products. The purpose of the ULTRAMOOR development effort is to lower the cost of making long-term, sustained measurements in the deep ocean.

2. A deepwater version of the Portable Coastal Observatory concept has recently been funded by NSF that includes a high-speed acoustic link with data rates in the range of 5 to 10,000 bps [3]. This Acoustically Linked Buoy Observatory is envisioned as a prototype system that could be deployed almost anywhere in the open ocean and allow real time access to data from anywhere in the water column or on the bottom. The advantage of this approach is lower initial and ongoing costs than competing technologies- especially for relatively low rate data sources.

Quality of Life

We are in the process of transferring the Portable Coastal Observatory equipment and systems to the USGS in Woods Hole, who plan to continue to operate it as part of their monitoring efforts for the MWRA in Boston Harbor. This work is related to the ongoing efforts to study and mitigate the effects of the Boston Harbor sewage outfall.

Related Projects

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3. A Moored Profiler with an acoustic connection to a small tethered buoy is being fabricated at WHOI and will be installed about 150 miles off of the New England coast this fall.

References

[1] http://128.160.23.41/

[2] D. Frye, N. Hogg and C. Wunsch, "New-generation mooring system allows longer deployment," EOS, Vol. 83, No. 34, pp. 365-371, 20 Aug. 2002.

[3] D. Frye, "An acoustically linked seafloor observatory," presented at the ONR/MTS Buoy Workshop held in Seattle in April 2002.

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