AOML Data Pod System

Ulises Rivero, Christopher Meinen and Silvia Garzoli
NOAA Atlantic Oceanographic and Meteorological Laboratory, Miami FL

Table of Contents

1. Project Summary 1
2. Scientific and Observing System Accomplishments 2
3. Outreach and Education 4
4. Publications and Reports 4
   Publications by Principal Investigators 4
   Other Relevant Publications 4

1. Project Summary

The Climate Change Science Program has listed as a national priority the assessment of current climate change in the context of Earth's history and a determination of the likelihood of abrupt changes in this century. An integrated Earth system analysis capability, incorporating ocean now-casting, is needed to assess the current state of the climate system. Such capability would allow monitoring and analysis of rapid changes so that policy and decision makers can understand the risks involved and consider implementing programs to limit the impact of abrupt changes. A classic conundrum of physical oceanographic and climatic research seeking to study these problems has been how to measure the deep ocean and record data with instruments on the bottom of the ocean while also getting the data back to land quickly enough to be used in climate analysis and prediction. The ocean environment is a particularly challenging and harsh one for the electronics that are the heart of modern measurement systems, and the deep ocean is typically even less forgiving. Recent scientific research has demonstrated, however, the critical need for data throughout the full depth of the ocean if society is to improve understanding and prediction of climate changes. The development of instruments able to telemeter the data they measure to a ship on site was an advance towards the solution of the near real time problem. However, given the high cost and decreasing availability of ship time on research vessels, other options are needed.

This AOML/PHOD project has sought to develop a cost-effective system utilizing expendable 'data pods' which would collect data from a central instrument, self-release at a user pre-programmed interval, surface and transmit their data back to land via satellite. The main advantage of the project is that deployments could be made in remote areas, with a substantial reduction of needed ship time. Instruments would be deployed from a research vessel. Data will be transmitted via satellite for up to 4 to 5 years, depending on the instruments used. At the end of this period, scientists will be able to make a decision of whether or not to recover the instruments based on a cost effectiveness analysis. This conceptual design has the advantage of being adaptable to many different kinds of sensors and would serve not only the NOAA Climate Goal's needs but would also foster cross-goal and cross-line cooperative execution by addressing some needs of the Ecosystem Goal as well as the Weather and Water Goal.

This project proposed to develop an array of expendable glass tubes mounted around a frame housing an oceanographic instrument. The data will be ported from the instrument to an external data controller, which will then transmit the data by short-distance radio frequency (RF) to an array of expendable glass-tube data pods mounted on the anchor frame. The glass tube is a well-proven design for deep-ocean instrument housings. The cylindrical shape takes up less space on a mounting frame as compared to the glass sphere, allowing more data pods to be mounted on a smaller frame. The tubes can be designed to withstand full ocean depth to 6,000 meters. On a 5' diameter frame up to 18 glass tubes may be mounted. Under the system proposed here for development, these tubes would be released from the frame based on a user programmable time interval. As each tube is released it will contain the entire record from the instrument, not just the data obtained since the previously released tubes. This will guarantee continuity in the data set in the event that there is a failure in any of the tubes. The data will be transmitted to a base station via satellite. At the end of the deployment period, the instrument and data controller pod could be recovered, while the anchor frame would be expendable. The recovered instrument and data controller could then be reused in subsequent deployments at minimal additional cost (primarily replacement of batteries and the anchor frame). The name chosen for the system being developed at NOAA/AOML is the "Adaptable Bottom Instrument Information Shuttle System", or "ABIISS", pronounced "abyss".

2. Scientific and Observing System Accomplishments

This instrument-development program specifically seeks to create an 'add-on' package that could be used with many different ocean measuring moored instruments that are crucial for measuring ocean circulation and transport as well as other quantities needed for understanding sea-surface temperature and sea level changes.

Most of the hardware and software components for the ABIISS have been designed and fabricated at NOAA/AOML, with additional components purchased 'off-the-shelf' from commercial vendors. The system consists of three major modules: an oceanographic instrument, the main data controller and the data pod tubes. In the initial open-ocean tests of the prototype during FY09, the oceanographic instrument used was a pressure-equipped inverted echo sounder (PIES). The original funding of the development of the ABIISS system via the 2008 AADF program called for the development of a prototype that would operate with two different oceanographic instruments, a PIES and an Acoustic Doppler Current Profiler, ADCP. This report details ongoing progress in the design and testing of this system (see Figure 1).

Figure 1: ABIISS with a 300 kHz RDI ADCP

Testing and development during FY11 was significantly impacted by a delay in funding. Funds for FY11 were only made available in July 2011, with earlier indications suggesting that there

would be no funding for ABIISS during FY11. Initial work on a shallow water test of ABIISS continued into the early part of FY11 based on a test begun near the end of FY10. No additional testing at sea was done after the completion of the test in January due to the lack of funding. Nevertheless, bench testing of selected components continued as additional funding was being sought. Once funding was confirmed in July, parts for a 'deep-water' test at 750 m were ordered. However as some of these parts have delivery times of as much as six months after order, the deep ocean (750 m) test itself was pushed into FY12. The testing completed during FY11 did make some important advances, which are listed here:

- The ABIISS was recovered in January of 2011 after a 3 month deployment. This test confirmed the long-term seal of the data pods – crucial for future longer-term deployments.
- All hardware and software components were evaluated after recovery to evaluate their long-term capabilities.
- New data tubes and all necessary hardware components for a deeper deployment were ordered after July.
- Software modules were developed for top side communications with the main controller
- Watchdog timers (which checks and recovers for system crashes) for the data tubes were developed.
- Handshaking algorithm between the tubes and main controller was enhanced and tested.
- Bench tests were conducted to evaluate the power consumption of each component of the ABIISS system.
- Further tests were conducted using an alternate infrared system for communications between the data pods and main controller.
- In order to aid in the recovery of ABIISS, a GPS reporting unit using RF communications was developed and tested. This unit will report its position once the data-controlling system and integrated instrument reaches the surface.
- Mobile terminated messages tests were conducted using an Iridium 9601 SBD satellite modem. This will allow a user via a host computer the ability to communicate and send commands to the main data controller once it has surfaced. This will also allow for sending commands to the data pods once on the surface to reprogram for alternate uses, e.g. collecting sea surface temperature measurements for the Global Drifter Program, etc.

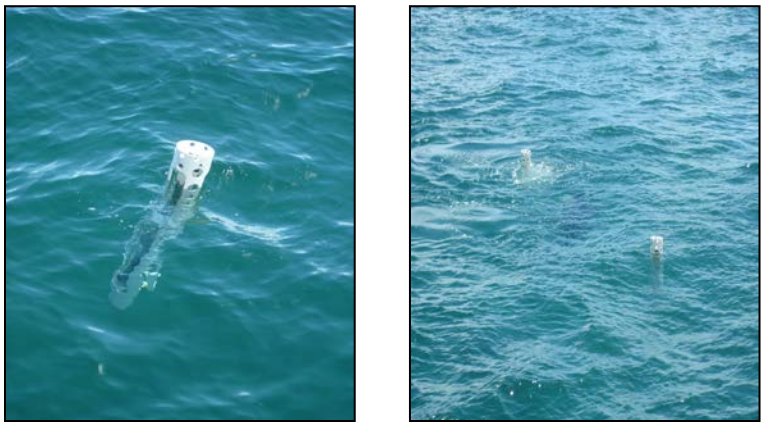

Figure 2: Data pods transmitting data from the surface via the Iridium Satellite Network

Figure 3: Recovered Data pods and frame after a 3-month deployment

More information and short videos of the ABIISS testing can be found on the project web page:

www.aoml.noaa.gov/phod/instrument_development/abiiss/

3. Outreach and Education

Traditional outreach and education activities have been limited to date in this instrument development project. However, ABIISS is set up for visitors and students to view and an engineer is always made available for answering any questions related to it. Additionally, cooperation and exchange of technical ideas has been going on between the PhOD engineers and colleagues at IFREMER who are working on a related development project. Collaboration with this group and others is expected to continue.

4. Publications and Reports

Publications by Principal Investigators

A technical report/paper will be prepared when the ABIISS development has been completed. At this stage, reports would be premature.

Other Relevant Publications

Because the ABIISS data pod system is still under development, no outside groups are using the system yet. As such, there are no outside relevant publications.