Annual Report for Period: 06/2011 - 05/2012

Principal Investigator: Friedrichs, Carl T.
Organization: William & Mary Marine Inst
Submitted By: Friedrichs, Carl - Principal Investigator
Title: Collaborative Research: The Role of Wind in Estuarine Dynamics

Project Participants

Senior Personnel
Name: Friedrichs, Carl
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Cartwright, Grace
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student
Name: Fall, Kelsey
Worked for more than 160 Hours: Yes
Contribution to Project:

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners
University of Maryland Center for Environmental Sciences
Old Dominion University

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)
Findings:
The VIMS team is focusing on analysis of velocity and turbulence measurements collected by the arrays of Acoustic Doppler Velocimeters. Although the data was successfully recovered a few weeks ago from our first field experiment (see attached activities file), we do not have significant findings to report at this time.

Training and Development:
This project has already provided extensive hands-on research experience a MS graduate student (Kelsey Fall) who assisted with field deployments and recoveries.

Outreach Activities:

Journal Publications

Books or Other One-time Publications

Web/Iternet Site

Other Specific Products

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Conference Proceedings

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:
Activities and Findings: Any Outreach Activities
Any Journal
Any Book
Any Web/Internet Site
Any Product
Contributions: To Any within Discipline
Contributions: To Any Other Disciplines
Contributions: To Any Human Resource Development
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering
Any Conference
Research activities (associated with the entire field component of this collaborative, multi-institution project)

Overview

The first year of our study on the role of wind in the dynamics of estuarine circulation was dedicated to preparing for and carrying out the first of three field experiments in the Chesapeake Bay estuary. The spring 2012 experiment, recently completed, was designed not only to examine wind-driven circulation modes in three-dimensional detail, but also to test the hypothesis that wind mixing is a dominant contributor to the energy driving the classical two-layer circulation, at least in estuaries with long fetches and weaker tidal mixing. We anticipated that delineating these circulation details and testing the hypothesis would require an intense effort, a program including a comprehensive moored instrument array and extensive shipboard measurements. In addition to conventional taut-wire moorings and instrumented bottom landers, a rigid tower equipped with a vertical array of acoustic Doppler velocimeters (ADV’s), temperature, conductivity, and oxygen (TCO) recorders, and acoustic anemometers was planned within the central array transect.

Deploying, maintaining, and recovering such an intense array in the active shipping lanes of Chesapeake Bay required a substantial effort. But it also required a substantial amount of good fortune. With the exception of one acoustic release, all instrumentation was recovered. Adding to this good fortune was a large variability in atmospheric forcing, ranging from a two-week interval of remarkable (especially for the typically lion-like early March) calm to a three-week interval of continuously strong winds.

Following the deployment of the fixed instrument array, a campaign of shipboard measurements was carried out to provide detailed, repeat mapping of properties both within the array and over a broader spatial context. The primary platform for these measurements was a towed undulating vehicle—Scanfish. Interspersed with these surveys were turbulence measurements conducted via a dropsonde. Both Scanfish and turbulence surveys were conducted in back-to-back, 3-4-day series.

Array

The instrument array for our study was deployed in approximately the same configuration as proposed, with three cross-estuary transects in a 20-km mid-estuary reach. The study site was chosen 20km south of planned location to avoid exclusion zones and decrease potentially complicating interactions with lateral topographic features. The central array consisted of 9 stations, 8 of which were equipped with surface buoys with meteorological instrumentation. Bottom landers with Acoustic Doppler Current Profilers (ADCP’s), ADV’s, and TCO’s were deployed at 8 stations in the central array. Bottom landers without surface markers were deployed in the deep channel at all three transects. The rigid tower was placed in central transect, over the western flank of the deep central channel. Following deployment, meteorological sensors were mounted at 4m above the water and ADV’s and TCO’s were placed by divers throughout the water.
column. These sensors were complemented by instrumentation mounted on a bottom lander and on the nearby surface buoy.

In order to provide a sufficient number of surface platforms to resolve the wind field, a small fleet of existing buoys was augmented by construction of 7 new buoys patterned on the CODE continental shelf buoys. These buoys, equipped with instrument towers and radar reflectors, proved effective in minimizing roll that might diminish the accuracy of wind measurements. Meteorological sensor data loggers were equipped with Bluetooth data transfer capability to enable control and downloading from small research vessels. In addition to these buoys, 8 new bottom landers were constructed.

The instrument array was deployed during the week of 12 March. Launching the array went smoothly, although it required two days longer than planned. The primary limiting factor in this effort was the setup time: preparing, testing, and mounting the instrumentation. Most underwater instruments were in place for 11-12 weeks. Meteorological sensors mounted on the 14 surface buoys will record through November 2012. A skeleton array of underwater sensors will be kept in place until the fall intensive array is deployed in September 2012.

Tower deployment required a day of shiptime. Although experience has shown that the tower can be vulnerable to shipping and fishing activities, the first deployment was successful. All instruments were recovered and data recovery was complete. The tower sank further into the soft sediments than anticipated and the bottom mounting pad will require a redesign. This sinking did not compromise the science, but made recovery more difficult because approximately a ton of mud was attached to the bottom pad when it was pulled out of the sediment.

Shipboard

The calm weather of the first week of operations in March was a welcome aid to mooring activities. However, when the unseasonal calm extended beyond the second week, we became concerned that a study of wind response would lack any forcing, much less a statistically desirable variation. Mother Nature made up for this lack by providing a month following of strong and variable winds. The benefit to our study of having both calm and winds goes beyond facilitating mooring operations: we now have a well-measured interval of low-wind forcing to compare with the responses to winds. This comparison may provide substantial benefit to numerical experiments by mimicking the conditions under which many process simulations are run: spin up the model and then turn on the forcing when steady state has been achieved.

Scanfish towing and turbulence probe drops were for the most part successful, even after the calm before the storm. The shipboard Scanfish control system failed during the surveys, requiring a backup replacement by the University of Maryland Scanfish. During the last week of operations, the Scanfish altimeter failed. Surveys continued, but with sampling depths set manually on the fly.