The Integrated Coastal Observation System (ICOS): A Real-time Underway Measurement System for Coastal Waters

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I. INTRODUCTION

The Integrated Coastal Observation System (ICOS) represents an improvement in the capabilities of underway coastal marine measurements by incorporating *in situ* biological, chemical, and physical sensors in an undulating vehicle with a mobile, sea-going laboratory van capable of further analysis of critical seawater properties on pumped samples. The combination of synoptic, simultaneous physical, chemical and biological data will support integrated modeling efforts in attempts to understand carbon cycling, sediment dynamics, phytoplankton dynamics and zooplankton distributions in the coastal oceans. Exciting undergraduate and graduate educational opportunities exist in real-time observations and display of nearshore (backyard) environmentally relevant properties.

The coastal ocean is a critical region. Due to steep gradients, complex dynamics, and strong physical/biological/chemical interactions, high resolution, synoptic observations are necessary to accurately observe, model, and predict coastal ocean processes. Recent advancements in remote sensing (satellite and aircraft), stationary platforms (moorings, towers) and individual sensors (especially optical) have dramatically increased our understanding of coastal processes, but mesoscale and submesocscale processes remain poorly understood due to a lack of instrumentation capable of rapid, synoptic three-dimensional observations of key physical, biological, and chemical parameters.

The University of Massachusetts Boston therefore has incorporated *in situ* biological, chemical, and physical sensors into an undulating vehicle with a mobile, sea-going laboratory van capable of further analysis of critical seawater properties. This mobile lab/undulating vehicle system is capable of rapid, high resolution, simultaneous measurement of key fields such as temperature, salinity, depth, dissolved oxygen, nutrients, dissolved organic matter, chlorophyll, particle size distributions, and particle (plankton) composition.

II. CAPABILITIES

Capabilities include:

All Stainless Steel and Teflon Pumping System
Optical Plankton Counter
Meorological Station
Video Plankton Recorder
Self-contained GPS system
SeaBird 911 Plus CTD w/dissolved oxygen
Chl and CDOM fluorometers
Clean Hood for trace metal and organic work
AC-9 Spectral Absorption Meter
In-Line TOCN Analyzer
LISST 100 Particle Size Analyzer
In-Line Nutrient Analyzer

The high-resolution physical, chemical and biological data will support integrated modeling efforts in the coastal oceans. Measurements of the inherent optical properties of seawater will be used to test and refine these models. The complete, integrated mobile laboratory has been designed for maximum versatility (ships ranging from 40-300 feet) operating in a wide variety of coastal systems (estuarine to shelf/slope interactions), and for rapid response (hours to days depending on shipping speed) to episodic events (such as spills, harmful algae blooms, or hurricanes).

The system is composed of a ship-going laboratory van, the ECOShuttle, a towed undulating vehicle, a pumping system mounted on the ECOShuttle, and the Mini-Shuttle, a towed surface (<2m) instrumented depressor wing. Brief descriptions of the vehicles are below. Data from the ICOS maiden voyage in the Hudson River and New Jersey Shelf in the Summer of 2003 will be discussed.

A ECOShuttle

The ECOShuttle is a towed, undulating vehicle based on the Nu-Shuttle manufactured by Chelsea Instruments. It carries a Sea Bird Electronics SBE 9/11 CTD system which provides temperature, salinity and depth measurements. Fluorescent dissolved organic matter is measured by a SeaTech (CDOM—λ_{ex}=330 nm, λ_{em}=450 nm; bandwidth=60 and 65 nm respectively) fluorometer. A Chelsea Instruments UV Aqua-Tracka fluorometer (λ_{ex}=239 nm, λ_{em}=360 nm) also provides an indication of hydrocarbon concentration. Other instrumentation includes a chlorophyll fluorometer and optical backscatter sensor (OBS) manufactured by Sea Point Instruments and a YSI dissolved oxygen sensor provided by Sea Bird Electronics. An altimeter facilitates safe operation within a few meters of the bottom. With the current cable the maximum depth of operation is about 40 m at 8 knots.

In addition to on-board instrumentation, the ECOShuttle also incorporates a stainless steel, submersible pump which allows water to be continually supplied to the shipboard lab via a ½" ID teflon tube in the tow cable. This water may be distributed to a variety of in-line instruments and also allows discrete samples to be obtained for further analysis. In-line instruments include a time-resolved laser-induced fluorometry system which determines both CDOM spectra (λ_{ex} = 337 nm) as well as pyrene concentrations (Rudnick and Chen, 1998), and a AC-9 multi-spectral absorption meter (Wetlabs), a SeaBird thermosalinograph, in-line nutrient analyzers for nitrate, phosphate, and silicate (WS Envirotech), an in-line TOCN analyzer (Shimadzu), and a LISST-100 particle size analyzer (Sequoia Scientific). A fluid rotary and electrical slip-ring (Focal Technologies) incorporated into the winch (SeaMac) allow data, control, and fluid connections between the shipboard laboratory and the ECOShuttle. Complete details of this system are presented elsewhere (Gardner et al., 2003, in preparation).

B. Mini-Shuttle

The Minishuttle is based on a YSI/Endeco 2' V-fin depressor vane. Temperature, salinity and depth are measured with a 2" MicroCTD from Falmouth Scientific which also acts as a data acquisition system for CDOM and chlorophyll fluorometers manufactured by Seapoint Electronics, Inc. and for a dissolved oxygen sensor provided by Sea Bird Electronics, Inc.

Figure 1: ICOS van

Figure 2: Winch with hairy-faired cable. System being deployed off New York City.

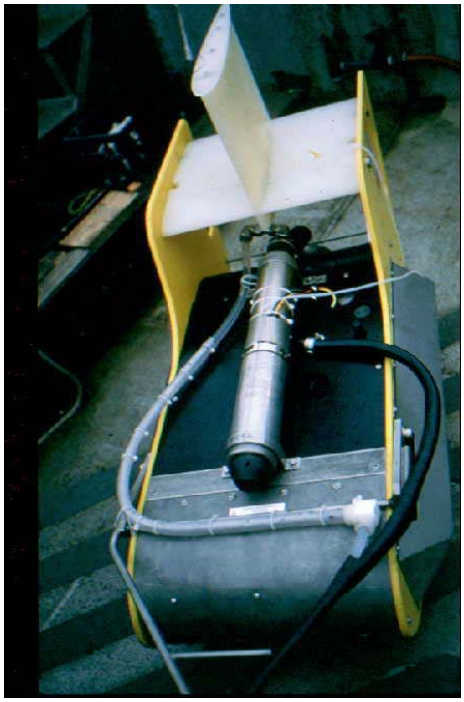

Figure 3: The ECOShuttle.

Figure 4: Francesco Peri inside the ICOS van.