Autonomous Environmental Profiling Moorings for Coastal Monitoring

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Introduction

• There are many reasons to monitor coastal environments such as marine protection, harbor protection, coastal science research, and environmental prediction.

• This can be technologically challenging due to fishing activity, navigation, biofouling, strong currents, etc.

• Fixed location resources offer distinct advantages over moving resources such as ease of interpretation and greatly reduced risk of system loss.

• Highly desired features
  • Real-time reporting
  • Water column profiles
  • Autonomous control
The “Barny” Trawl-Resistant Bottom Mount
Shallow water Environmental Profiler in Trawl-resistant Real-time configuration (SEPTR)

Deployment

No water column exposure the majority of deployment

Protection Configuration

ADCP Measurements

Profiling Configuration

CTD, Waves, & Optics Measurements

Near Real Time Data Transmission

Satellite Comms.
SEPTR technology enables near-real-time monitoring of waves and profiles of ocean velocity, temperature, salinity, and optics in heavily-fished, coastal waters.
Shallow water Environmental Profiler in Trawl-resistant Real-time configuration (SEPTR)

2 independent recovery buoys

profiling

CTD

ADCP

crawl resistant shape on bottom

Sound Speed

Waves

Currents

Temperature

Optics
Cape Gargano
Manfredonia
Gulf of Manfredonia

DART
Summer 2006
Field Experiment
Eddy Activity
Observed by SEPTR
Eddy Activity
Observed by SEPTR

Near Surface Currents (cm/s)

135 deg. T
Shallow water Environmental Profiler in Trawl-resistant Real-time configuration (SEPTR)

Adriatic Sea Experiments 2006
- 2 month long field demonstrations
  - winter experiment
    - 5 SEPTR Moorings
    - 111 total profiles (best 71 profiles)
  - summer experiment
    - 4 SEPTR Moorings
    - 302 total profiles (best 102 profiles)

Monterey Bay Experiment 2008
- 2 week long demonstration
  - 2 SEPTR Moorings
    - 91 total profiles (best 53 profiles)

Damariscotta Maine Experiment 2009 & 2010
- 10, 6, & 20 day long demonstrations
  - 1 SEPTR Mooring each year
    - 139 total profiles (best 91 profiles)
  - demonstration of benthic fuel cell charging SEPTR mooring

6.2 Dynamics of the Adriatic in Real Time (DART)

6.1 BIOSPACE

6.2 Unattended Sea-bed Power for In-water Operations
Bug: Benthic Unattended Generator

Simple Schematic: Benthic Microbial Fuel Cell
BUG equipped SEPTR
BUG equipped SEPTR

on the bottom

before deployment

recovery after 2 ½ months
Anode #1, Kaufman #409

Under SEPTR

Anode #2, Kaufman #408

Beside SEPTR

Anode #3, Kaufman #406-G shorted

Anode #4, Kaufman #410

Anode #5, Kaufman #404 exposed

Anode #6, Kaufman #407 inefficient

Anode #7, Kaufman #411

Anode #8, Kaufman #405 shorted
SEPTR batteries were recharged (slightly) in 2009 and in 2010.

- Batteries 2A&B: odd and even days (no charging)
- Batteries 1A&B: odd and even days (charging 09/07)
SEPTR Optical “puck”
2 backscattering channels & fluorescence

Chlorophyll-a from fluorescence

Monterey Bay, CA

Chlorophyll-a from fluorescence

Adriatic Sea, Italy

Chlorophyll-a from fluorescence

Damariscotta Maine
Technical Needs

• Optics sampling from 1 fluorescence channel and 2 backscatter channels are not sufficient for advanced ocean optics research topics. Additional optics sensors are needed.

• Globalstar has transmission issues due to lack of satellites, “bent pipe” principle, etc. Iridium performs better for most metrics.

• Transmission loss due to wave activity should be reduced if possible.

• Should use commercial parts where ever possible to reduce reliance on “one of a kind” manufacturing.

• Should use a standard computer operating system rather than a unique and proprietary operating system.
additional Optical “puck” added to profiler

Beam Attenuation Meter (BAM)

7 Channel Irradiance Sensor (OCR-507)
Invention

test deployment in pool (BOPPERS cover removed)

profile unit (top view)
- antenna (extended)
- 7 wavelength irradiance sensor

profile unit (bottom view)
- backscattering sensor
- beam attenuation meter
- fluorescence sensor
Bio-Optical Physical Pop-up Environmental Reconnaissance System (BOPPERS)

- Physical measurements: temperature, salinity, pressure, currents, waves.
- Bio-optical measurements: beam-attenuation coefficient, backscattering coefficient at 3 wavelengths, downwelling irradiance at 7 wavelengths, phytoplankton pigment (chlorophyll, phycoerythrin) and dissolved organic matter fluorescence.
Summary

• SEPTR has successfully demonstrated that a coastal profiling mooring can be successfully used for environmental monitoring due to technical achievements allowing enclosure in a trawl-resistant housing.

• Coastal monitoring works best when profiling moorings are used in groups to resolve dynamic features like eddies.

• Persistent powering of these moorings using renewable energy is under development.

• BOPPERS is an innovation from SEPTR with significantly better optics sampling, better data transmission, and ease of reproduction.

• The platform is adaptable and with a few changes can used for other types of environmental sampling and/or data transmission relay.

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Shallow water Environmental Profiler in Trawl-resistant Real-time configuration (SEPTR)

- SEPTR Specifications
  - 100 meter profiles
  - 1-24 programmable profiles per day
  - Battery power allows for 4 profiles per day for 1 month duration
  - Sensors
    - ADCP velocity
    - CTD & calculated SVP
    - Significant wave height & spectra
    - 2 Backscatter channels & Chl
  - Globalstar satellite communications
    - 5-10 minute duration transmission of near real-time data
  - Trawl-resistant shape
    - 2.2 meter diameter
    - variable weight, 570-760 kg
    - 70 cm height off bottom
  - Proven design at sea
    - 5 field demonstrations
    - 643 profiles in real sea conditions
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