Developing a Profiling Glider pH Sensor for High Resolution Coastal Ocean Acidification Monitoring

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Ocean Acidification

Driven by the ocean’s absorption of increasing atmospheric carbon dioxide ($\text{CO}_2$)
Ocean Acidification - Projections

2013 IPCC Fifth Assessment Report (AR5)
Links Between People and Coastal Acidification

Atmospheric CO₂

Nutrient Pollution and Other Local Factors

COASTAL ACIDIFICATION

Biological Changes

Socioeconomic Impacts

ACTIONS
Management Actions
Individual Citizen Actions

Other Human and Environmental Impacts
Traditional pH Monitoring Platforms
Traditional pH Monitoring Platforms

Most gaps can be addressed through advancements in pH sensor technology.
Improvements in Design and Application

Academic and Industry collaboration:
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Todd Martz, Scripps
Honeywell
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*Finalists in the Wendy Schmidt Ocean Health XPRIZE
Advantages of Glider-based pH Monitoring
Project Goals and Applications

- Develop and integrate a Deep-Sea ISFET profiling pH sensor into a glider and conduct laboratory testing and calibration

- Conduct glider deployments to demonstrate high resolution measurements of pH in coastal regions in near real-time

- Determine natural variability that will provide a framework to better study organism response and design more realistic experiments

- Identify and monitor high-risk areas that are more prone to periods of reduced pH and/or high pH variability

➤ Enable better modeling and management of essential habitats in future, more acidic oceans
Sensor Development and Integration

Deep-Sea DuraFET profiling pH sensor

Power/Data Connector

ISFET Sensor and External Reference Electrode

MODIFICATION

ph sensor integrated with pumped CTD

INTEGRATION

Glider Payload Bay

CTD & pH sensor

Glider Payload Bay

Slocum Glider

Aanderaa optode

ECO puck
Tank Tests

- Conditioning time: 4-6 days
- Sensor precision:
  - Tank: +/- 0.000-0.007
  - Field: +/- 0.000-0.055
First pH Glider Deployments

July/Aug 2018 Deployment

May 2018 Deployment

Center for Ocean Observing Leadership
pH Response Time Lag

Corrected on an individual segment basis
pH Response Time Lag

- pH uncorrected
- pH corrected
- pH difference (corrected - uncorrected)

Optimal Time Shift

Center for Ocean Observing Leadership
Cross Shelf Profiles

May 2018 – NJ cross-shelf
Cross Shelf Profiles

May 2018 – NJ cross-shelf
Cross Shelf Profiles
May 2018 – NJ cross-shelf
pH-Temperature-Salinity Relationships

A: Near-shore surface water
B: Mid-shelf surface water
C: Shelf break
D: Low pH bottom water (mid-shelf and shelf break)
Next Steps – Glider-Based OA Networks

Regional Level

A Regional Slocum Glider Network in the Mid-Atlantic Bight Leverages Broad Community Engagement

Schofield et al. 2010, MTS

MARACOOS
Ocean Information for a Changing World

OCEAN OBSERVATORIES INITIATIVE

Rutgers
Center for Ocean Observing Leadership
Next Steps – Glider-Based OA Networks

National Level

Toward a U.S. IOOS® Underwater Glider Network Plan:
Part of a comprehensive subsurface observing system

“Glider technology may be able to resolve some of the issues involved in measuring essential ocean variables like sea surface salinity, pCO$_2$, pH, nutrients, and phytoplankton biomass, health, and composition.”

Glider tracks along the U.S. coast: 2002-2014

“As pH sensors mature, gliders will provide excellent platforms for monitoring ocean acidification.”
Next Steps – Glider-Based OA Networks

Global Level

Testor et al., in prep Ocean Obs’19

Center for Ocean Observing Leadership