The development and validation of a profiling glider deep ISFET-based pH sensor for high resolution observations of coastal and ocean acidification

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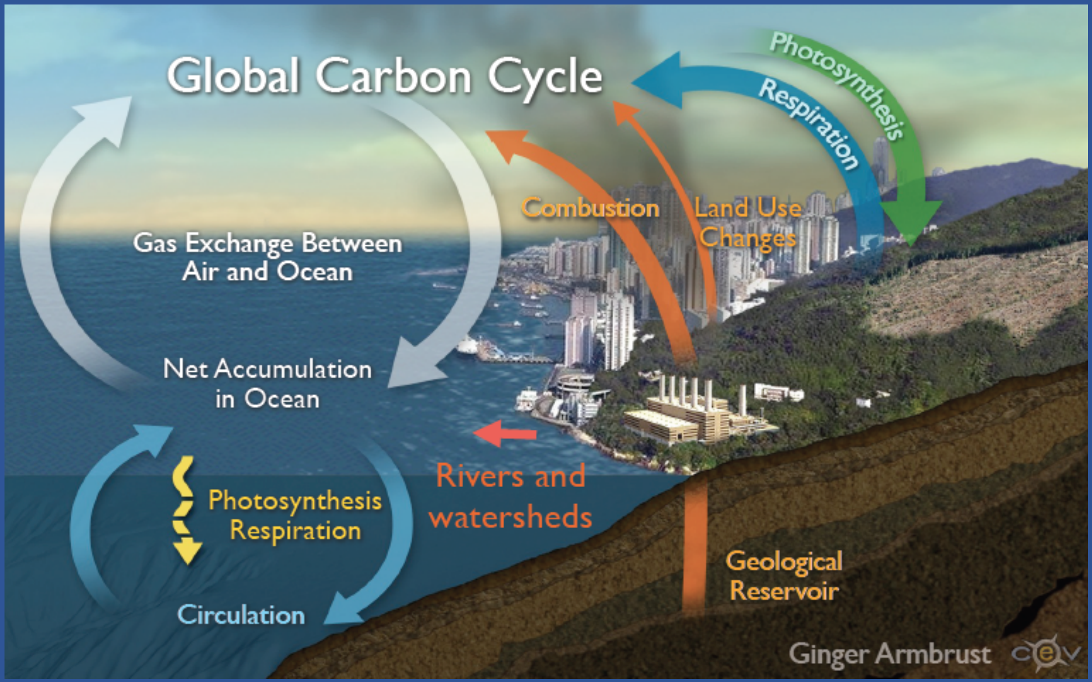
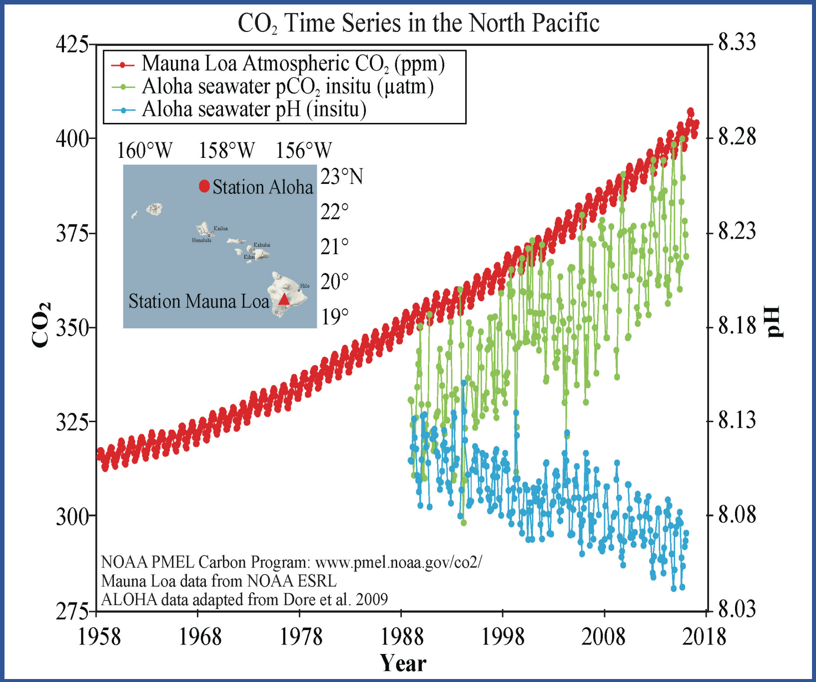
Clayton Jones

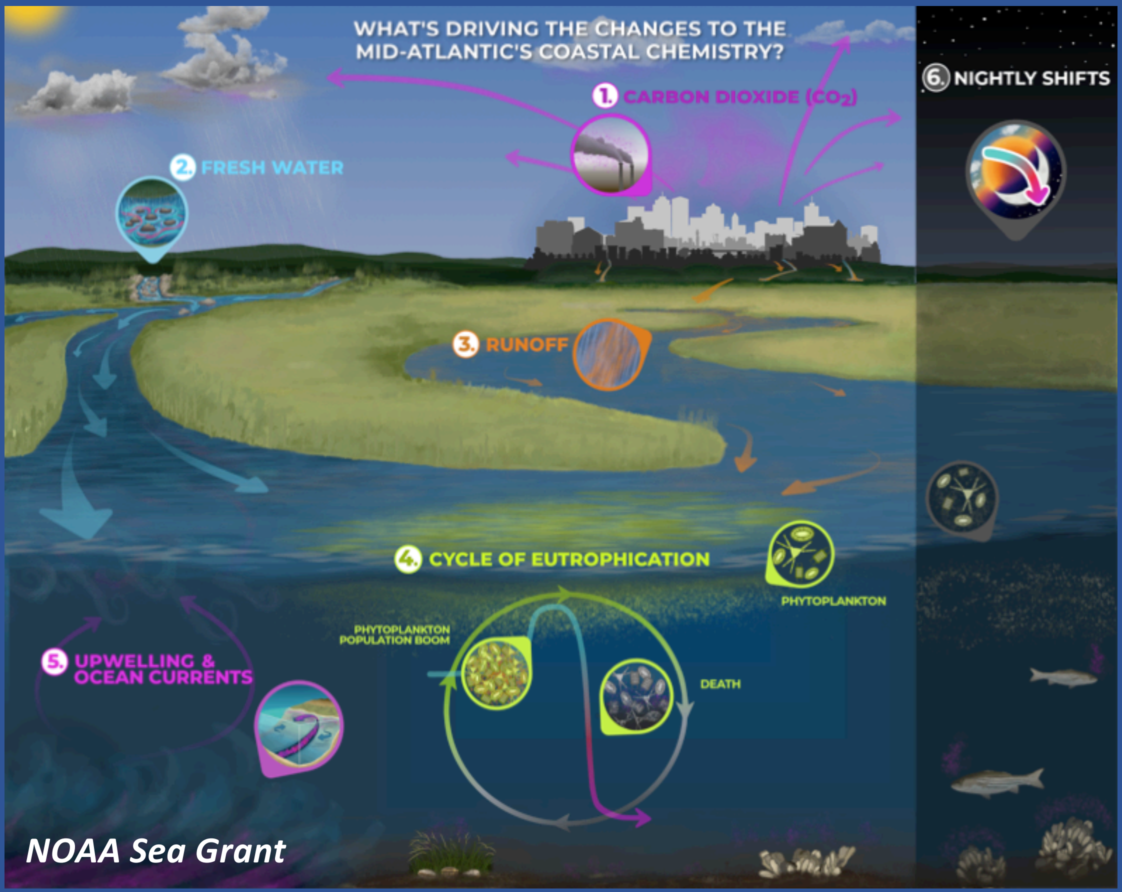
Ocean Acidification

Driven by the ocean's absorption of increasing atmospheric carbon dioxide (CO_2)



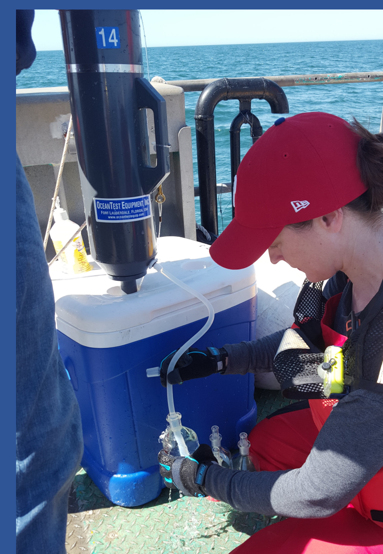


Coastal Acidification

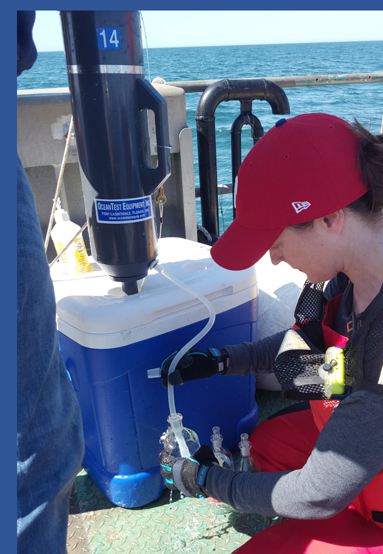


High variability and complexity in coastal shelf systems

Traditional OA Monitoring Platforms



Traditional OA Monitoring Platforms



Most gaps can be addressed through advancements in sensor technology

Improvements in pH Sensor Design and Application

Depth-profiling deep-sea ISFET pH

Johnson et al., 2016

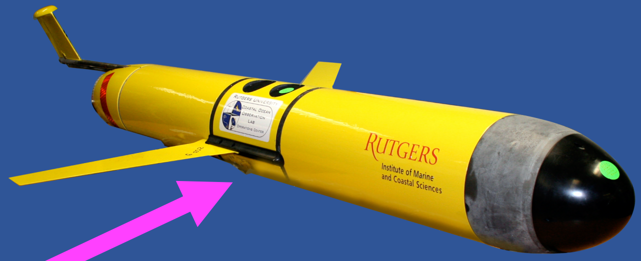
Academic and Industry collaboration:

Ken Johnson, MBARI
Todd Martz, Scripps
Honeywell
Sea-Bird Scientific

*Finalists in the Wendy Schmidt Ocean Health XPRIZE

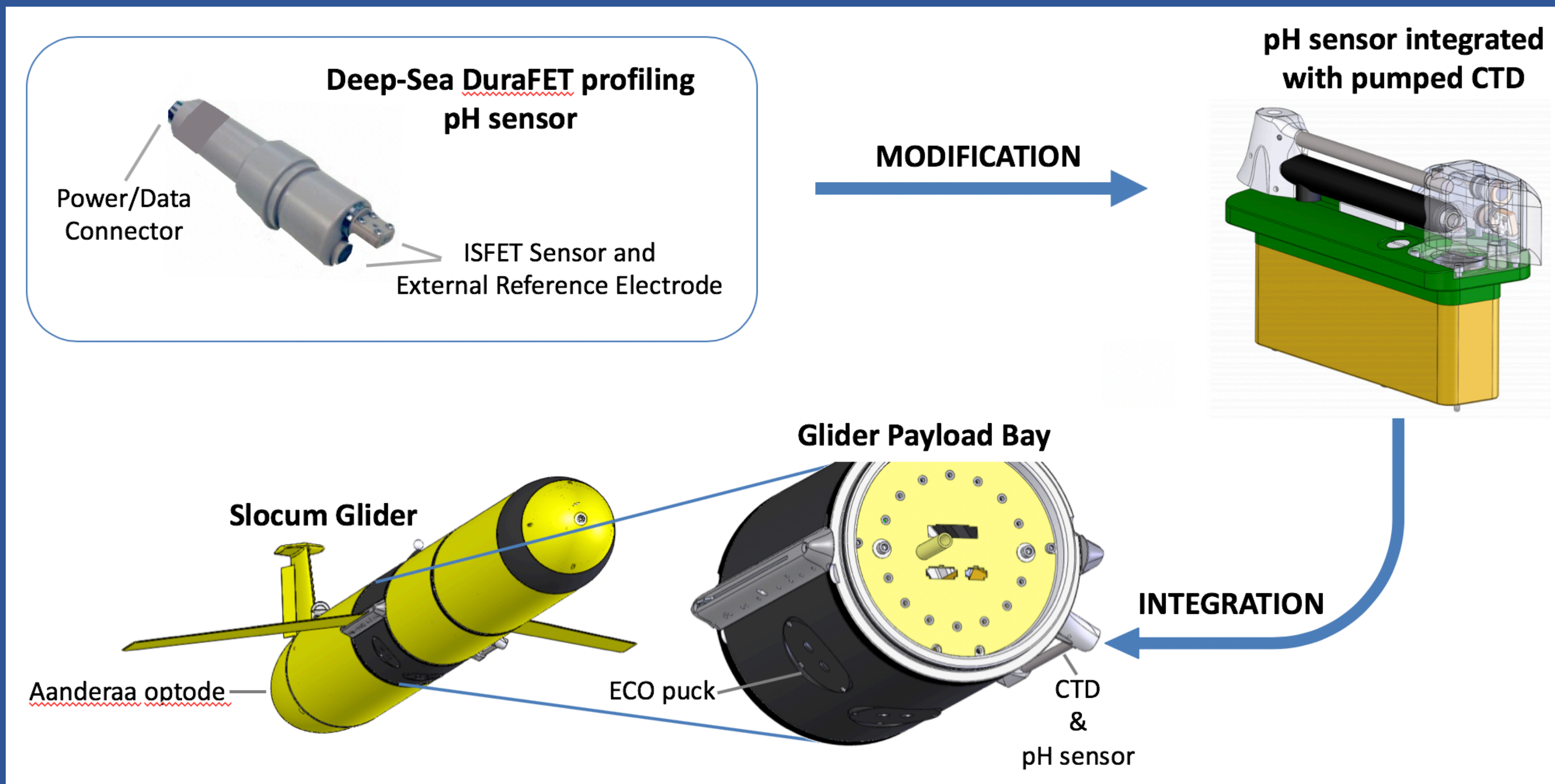
Project Goals

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

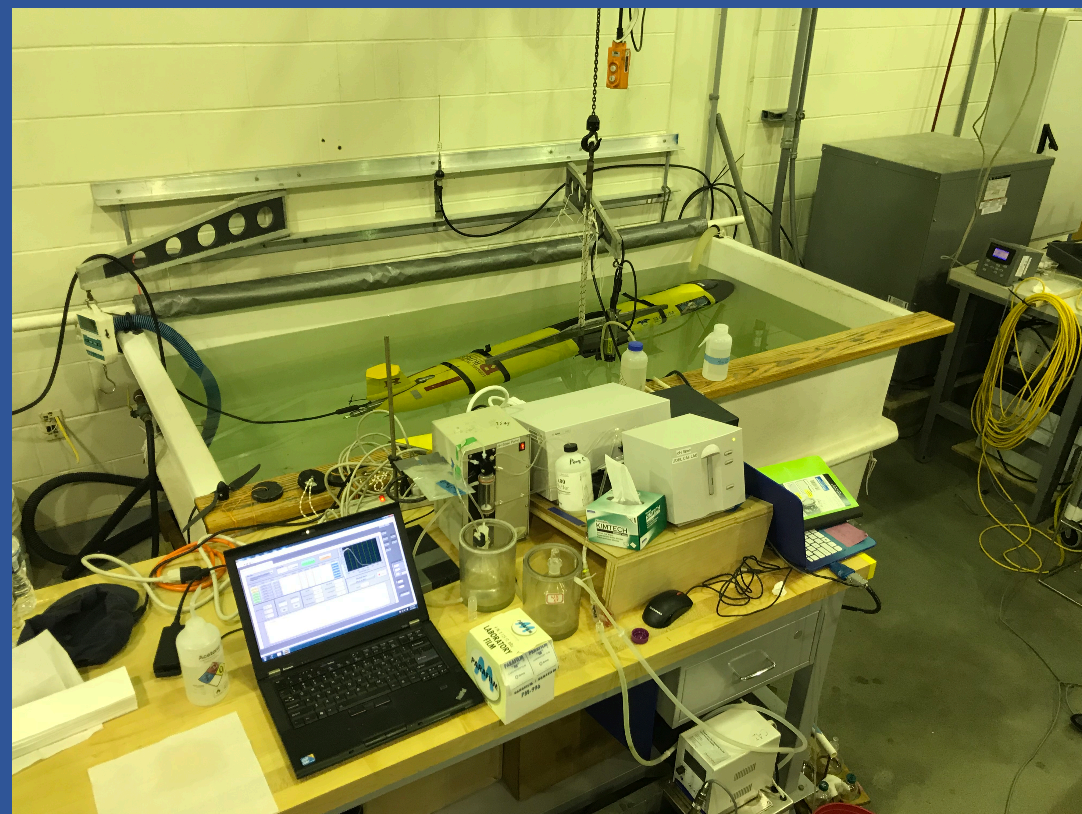


- Conduct glider deployments to demonstrate high resolution measurements of pH in coastal regions in near real-time

Sensor Development and Integration

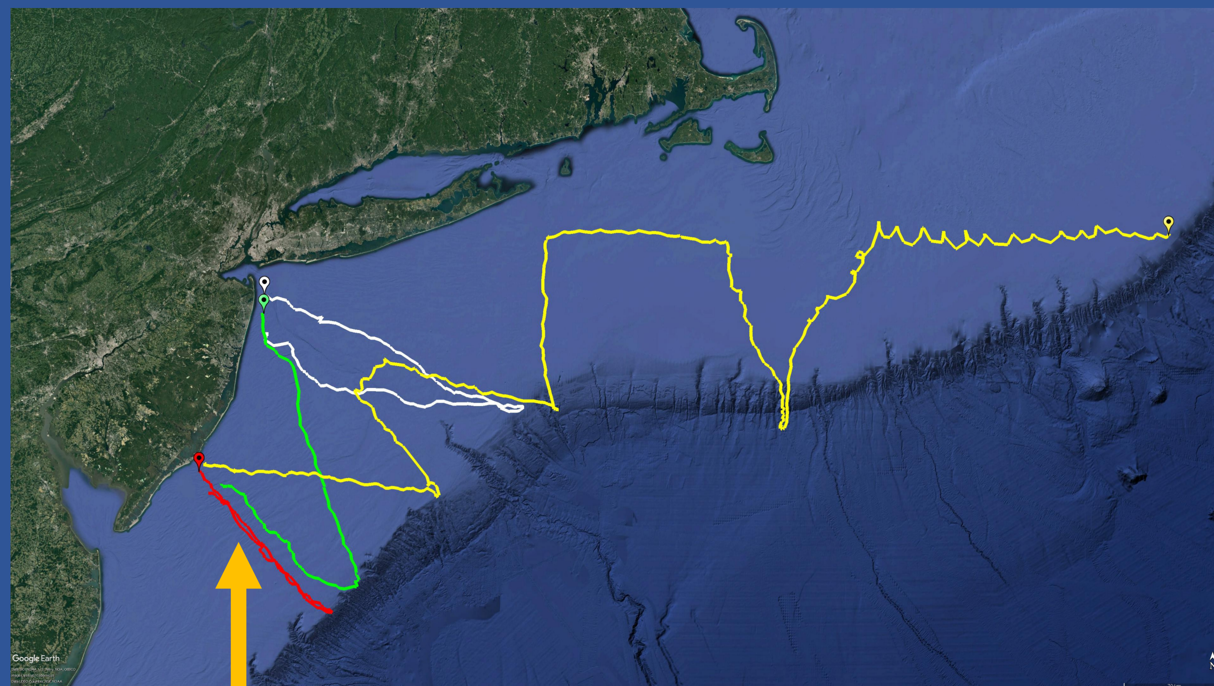


Tank Tests

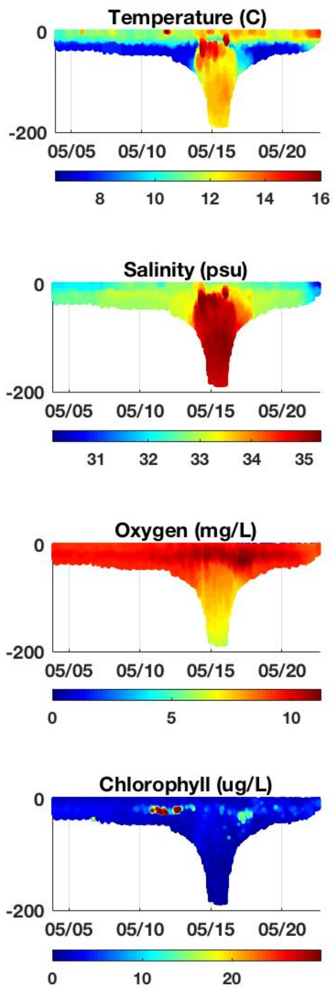


- Conditioning time: 4-6 days
- Sensor accuracy: 0.000 – 0.015
- Sensor precision: 0.000 –0.007

pH Glider Deployments



May 2018 Deployment



Cross Shelf Profiles

May 2018 – NJ cross-shelf

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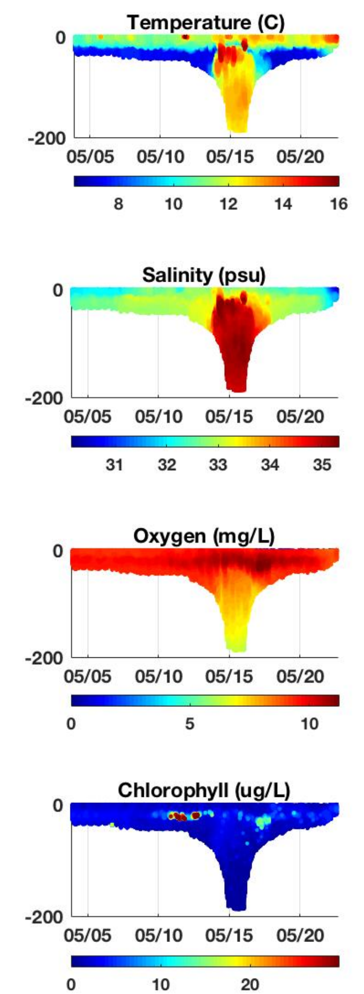
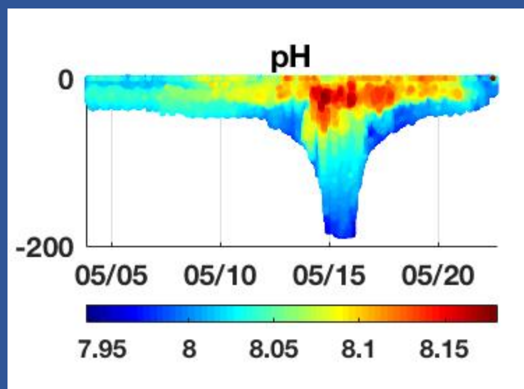
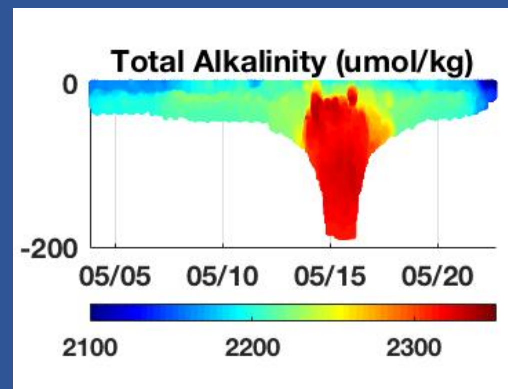
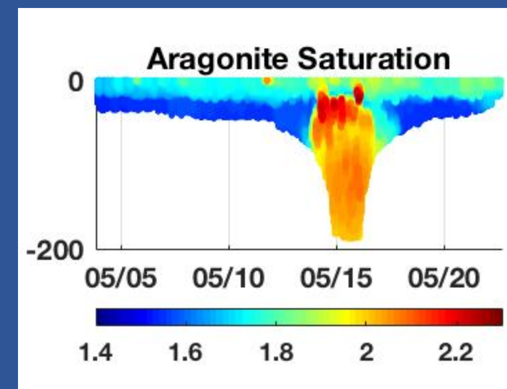
May 2018 – NJ cross-shelf

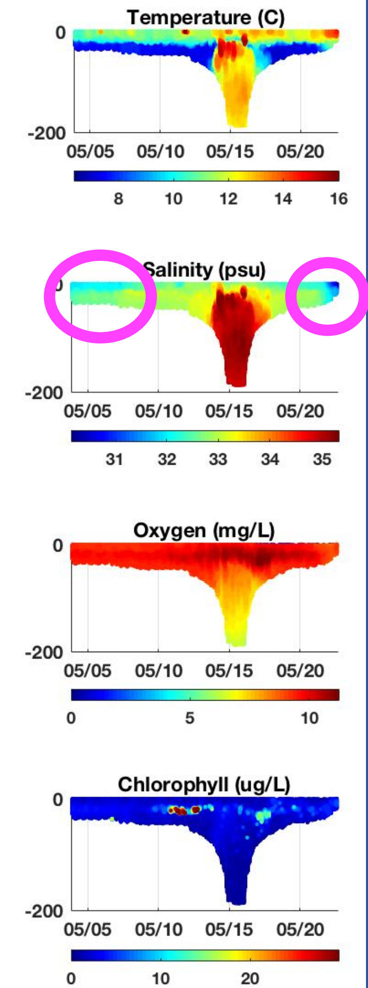






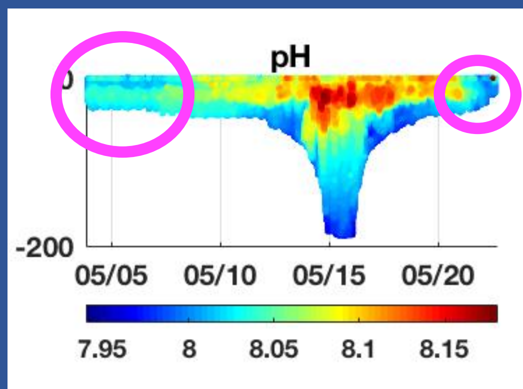


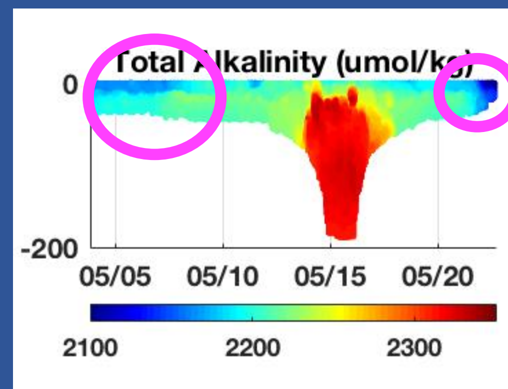
- Field accuracy: 0.001 – 0.017 pH units
- Field precision: 0.0007 – 0.008 pH units

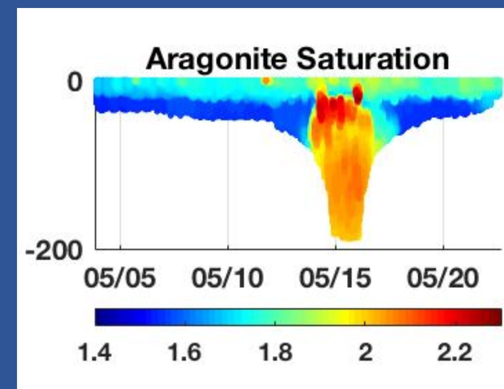


Cross Shelf Profiles

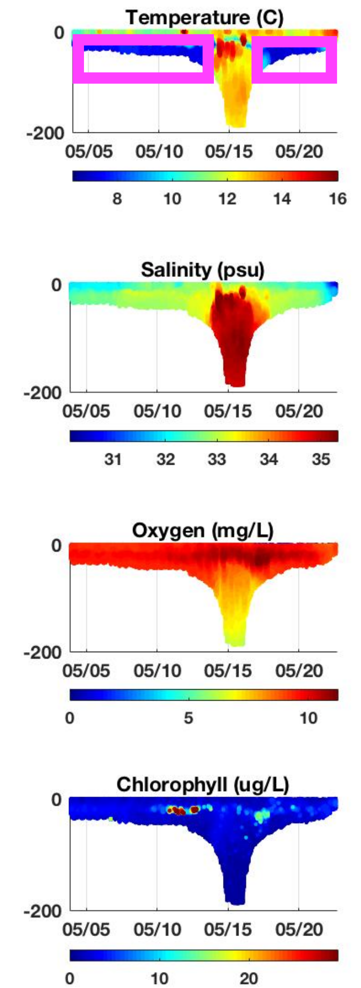
May 2018 – NJ cross-shelf







- Lower pH and TA occurred nearshore after precipitation events



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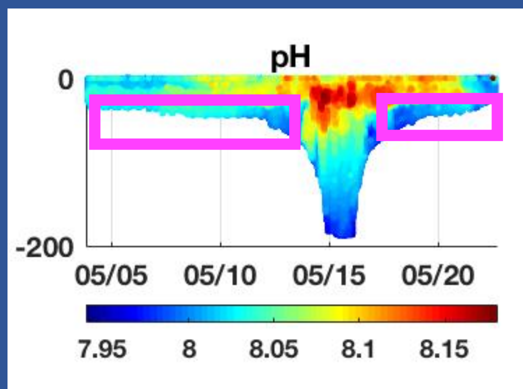
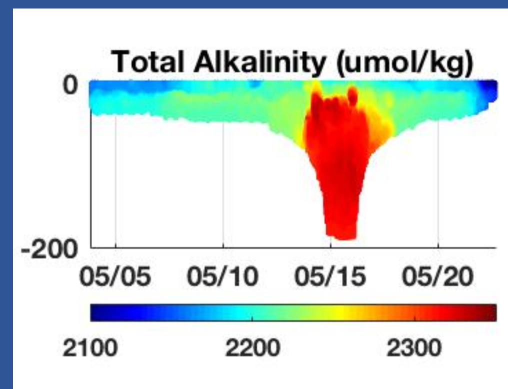
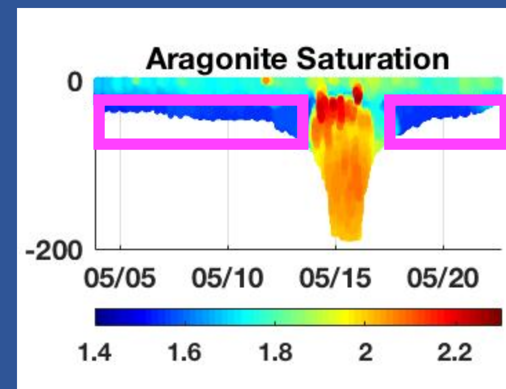
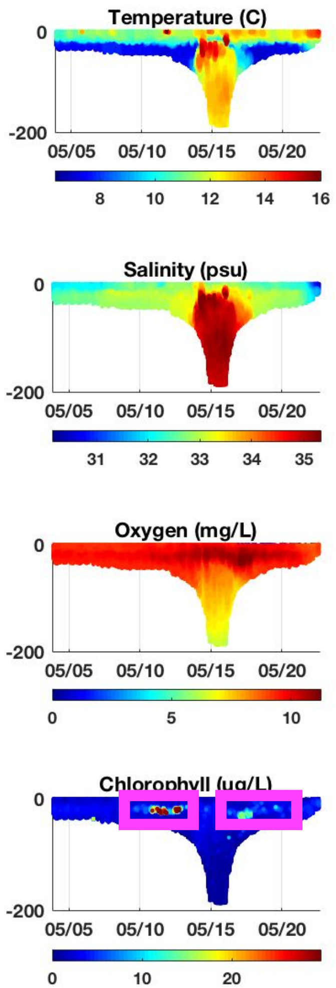




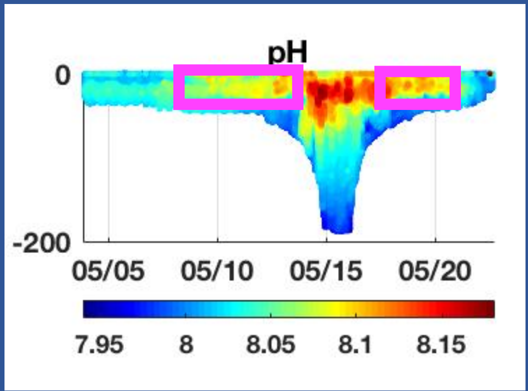


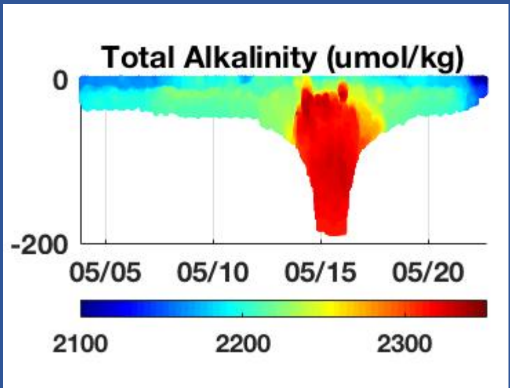
- Lowest pH and Ω_{Arag} in middle shelf Cold Pool bottom waters

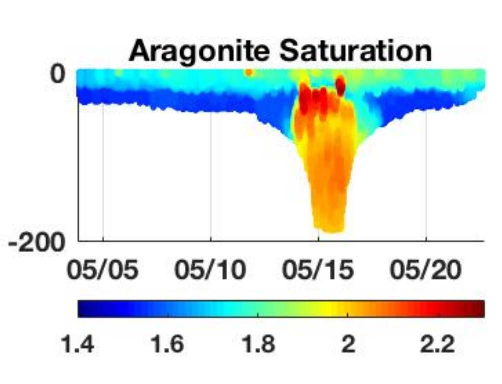


Cross Shelf Profiles

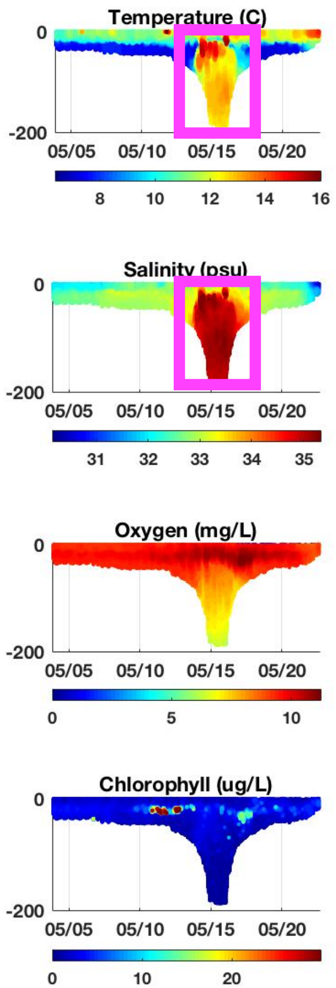
May 2018 – NJ cross-shelf







- Higher pH observed in subsurface chlorophyll maximum



Cross Shelf Profiles

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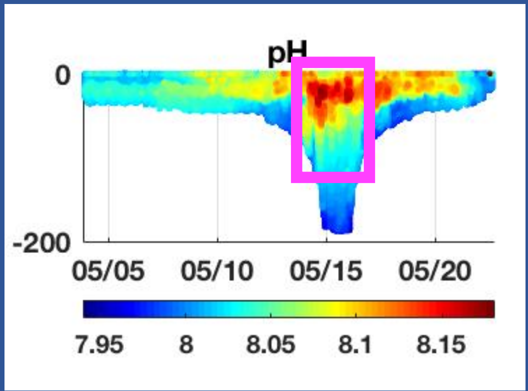
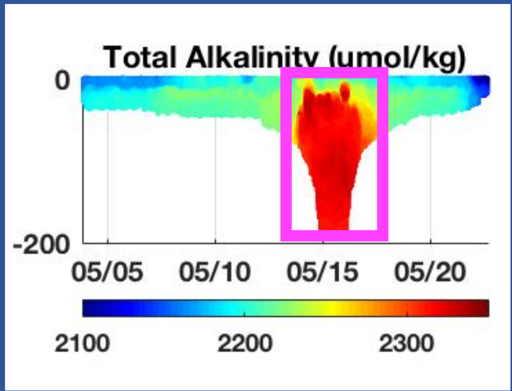
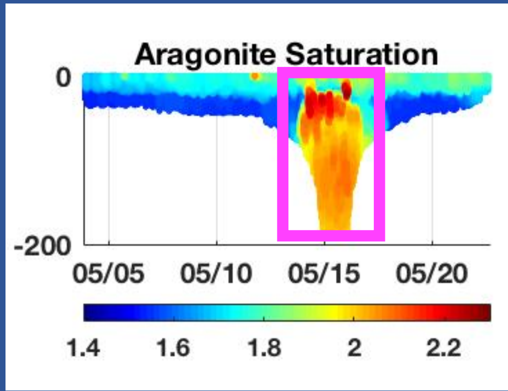


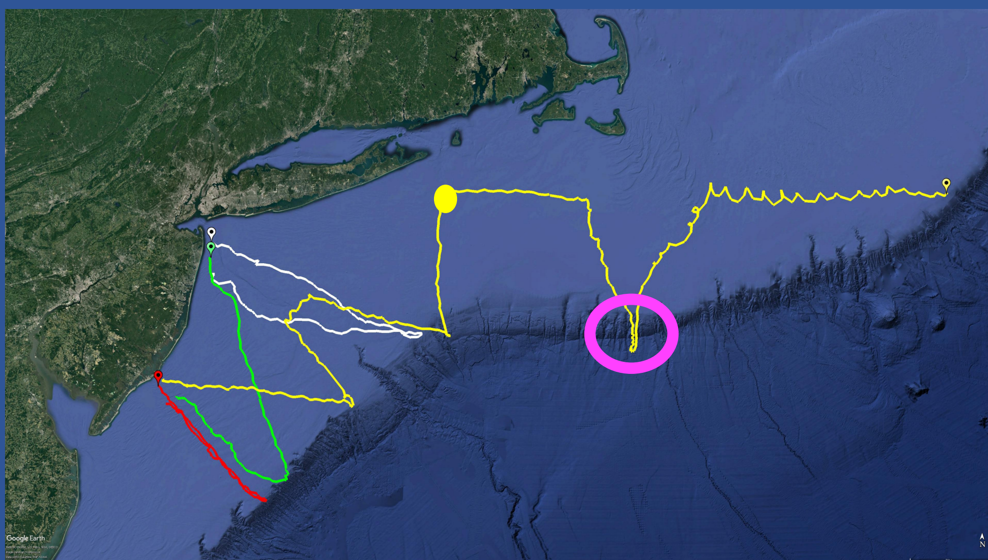




- Highest pH and Ω_{Arag} in warm, salty, alkaline water mass

Challenges to Overcome

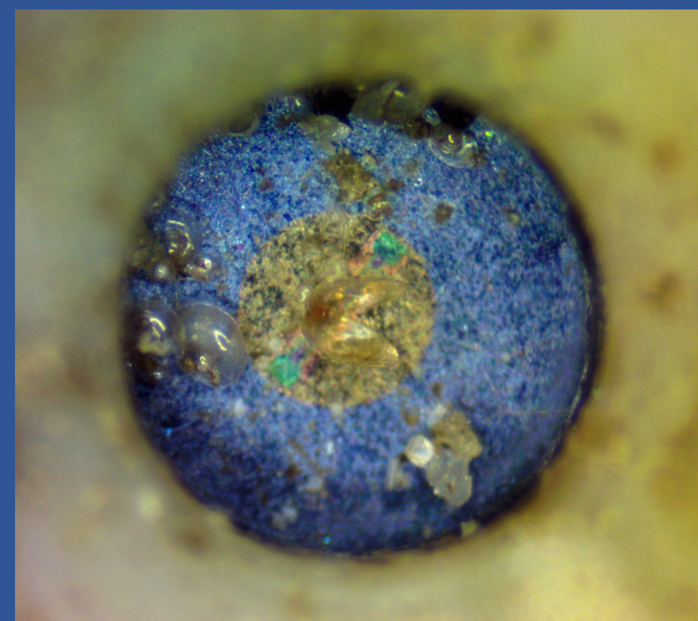
- Biofouling



pH offsets after warm-core ring: -0.144 to +0.081

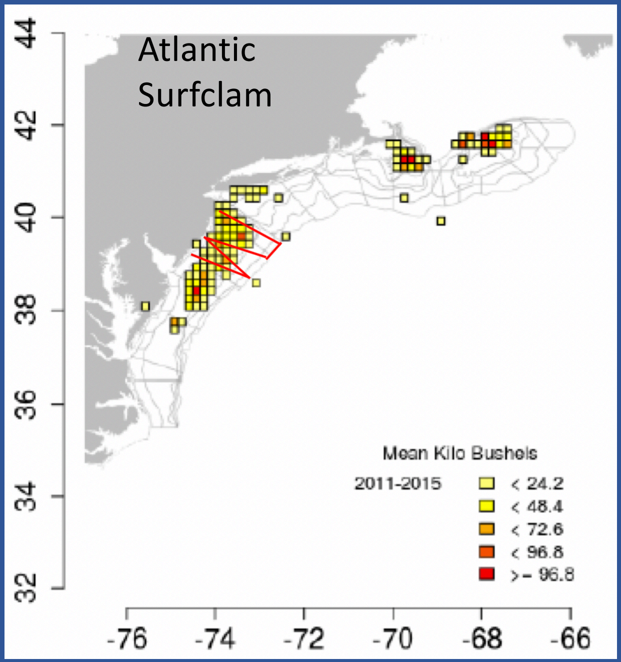
pH offsets upon recovery: -0.084 to +0.249

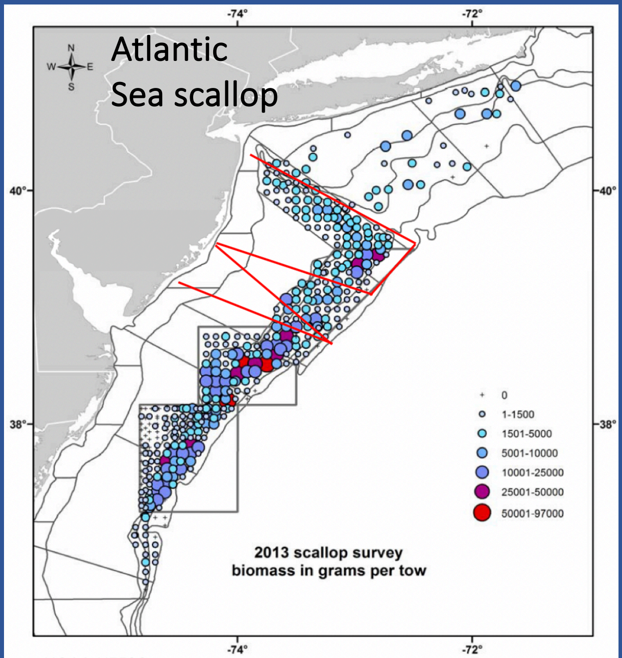
Young clams on the pH sensing element



Applications – Habitat Assessment

- Determine natural variability and monitor habitats of species that are sensitive to ocean acidification



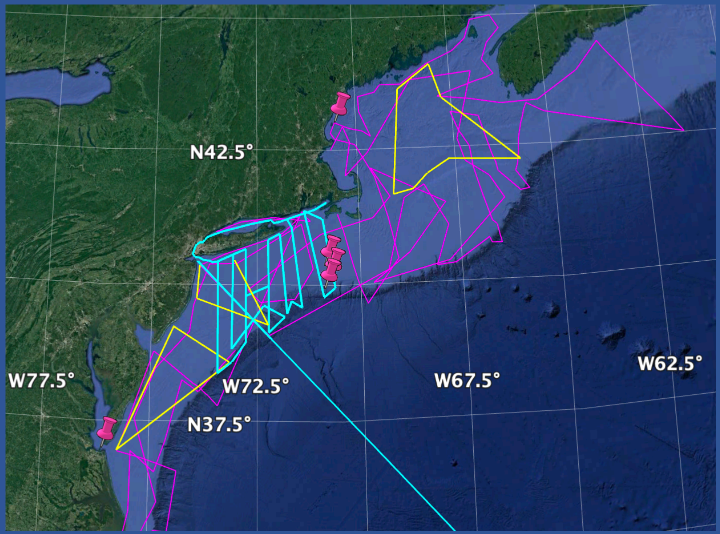


Seasonal/Habitat efforts: Elizabeth Wright-Fairbanks

Applications – Optimizing OA Observations

"Optimizing Ocean Acidification Observations for Model Parameterization in the Coupled Slope Water System of the U.S. Northeast Large Marine Ecosystem"

1. *Employ seasonal deployments with gliders integrated with deep ISFET-based pH sensors*
2. *Add carbonate chemistry measurements to existing cruises for optimization*
3. *Optimize an ecosystem biogeochemical (BGC) model that simulates carbonate chemistry*
4. *Integrate existing and new observations into regional databases for user access through two U.S. IOOS Regional Associations*



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