Adaptive Water Quality Sampling with Autonomous Vehicles with Applications to Nitrate DepositioN

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INTRODUCTION

- autonomous vehicles can drastically enhance aquatic sampling resolution
- automated discovery and tracking of pollution
- rapid low-cost access to remote locations
- model validation and parameter identification

Current Sensor Payloads:


Dissolve Oxygen Sonde

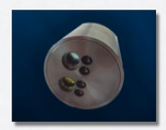

Multi-probe Sonde


Nitrate Sonde


Multi-beam Sonar


Single-beam Echo-Sounder

Up-coming Sensor Payloads:


Oil-in-Water Locator


Thermal Camera

Potential Applications

- Spatio-temporal hypoxia modeling
- Coastal nutrient (nitrogen, phospharus) hot-spot discovery and monitoring
- Sediment thickness monitoring
- Algal hotspot detection
- Submerged aquatic vegetation monitoring

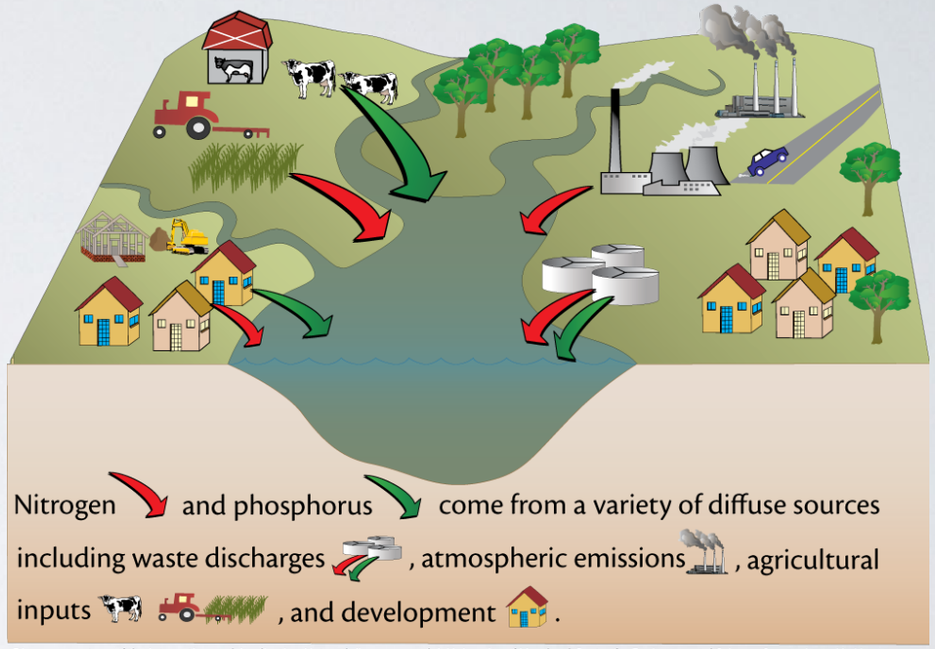
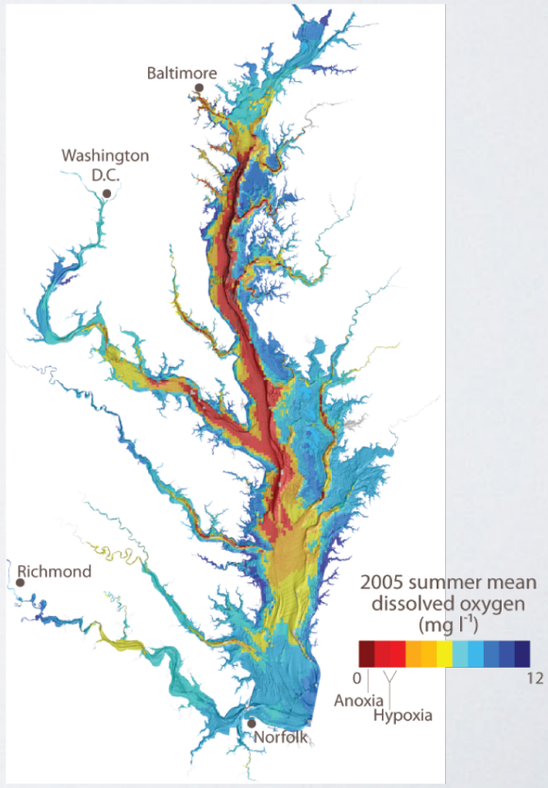
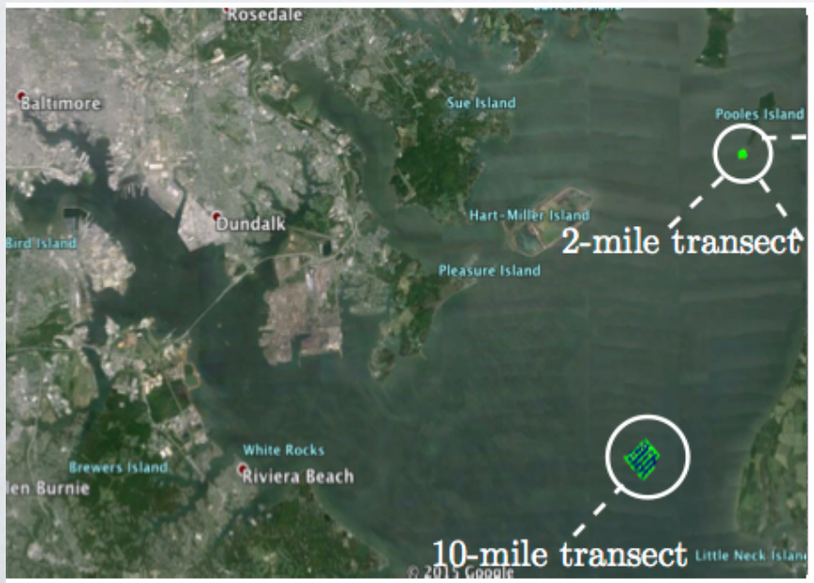


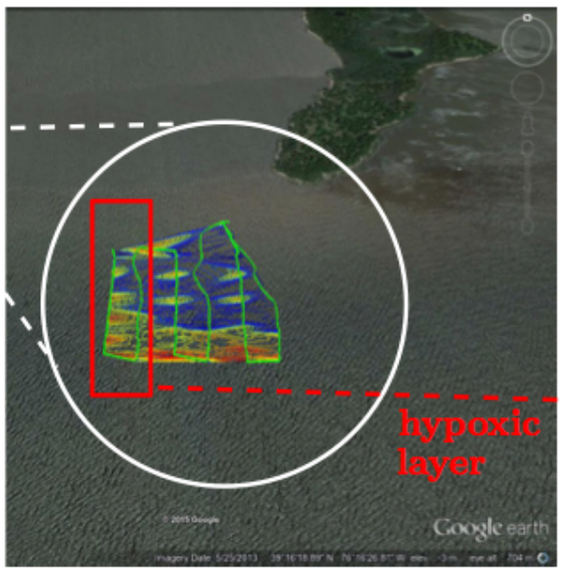
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Lane, H., J.L. Woerner, W.C. Dennison, C. Neill, C. Wilson, M. Elliott, M. Shively, J. Graine, and R. Jeavons. 2007. Defending our National Treasure: Department of Defense Chesapeake Bay Restoration Partnership 1998-2004. Integration and Application Network, University of Maryland Center for Environmental Science, Cambridge: MD.

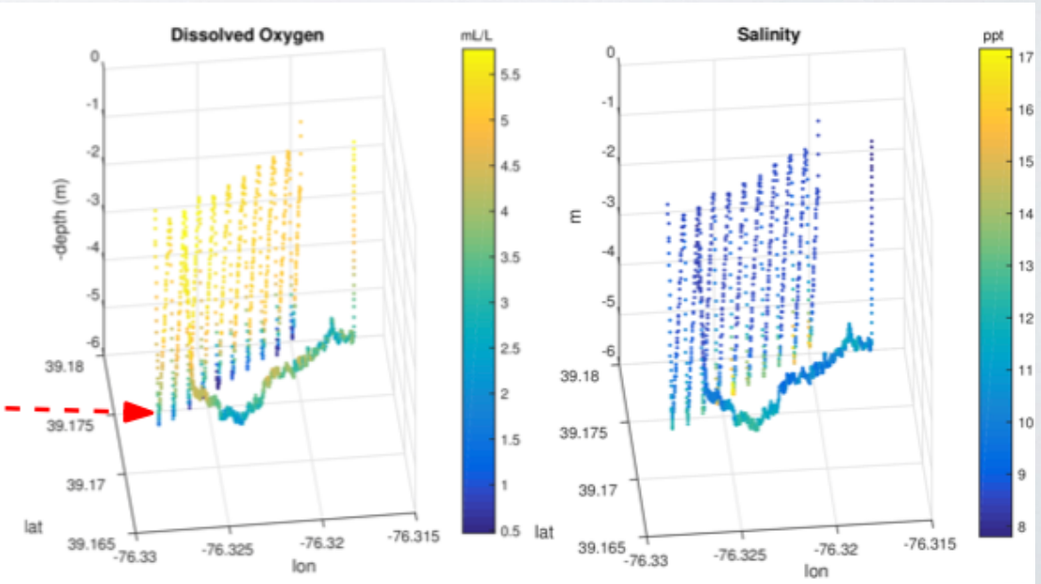


Autonomous vehicles for environmental sensing

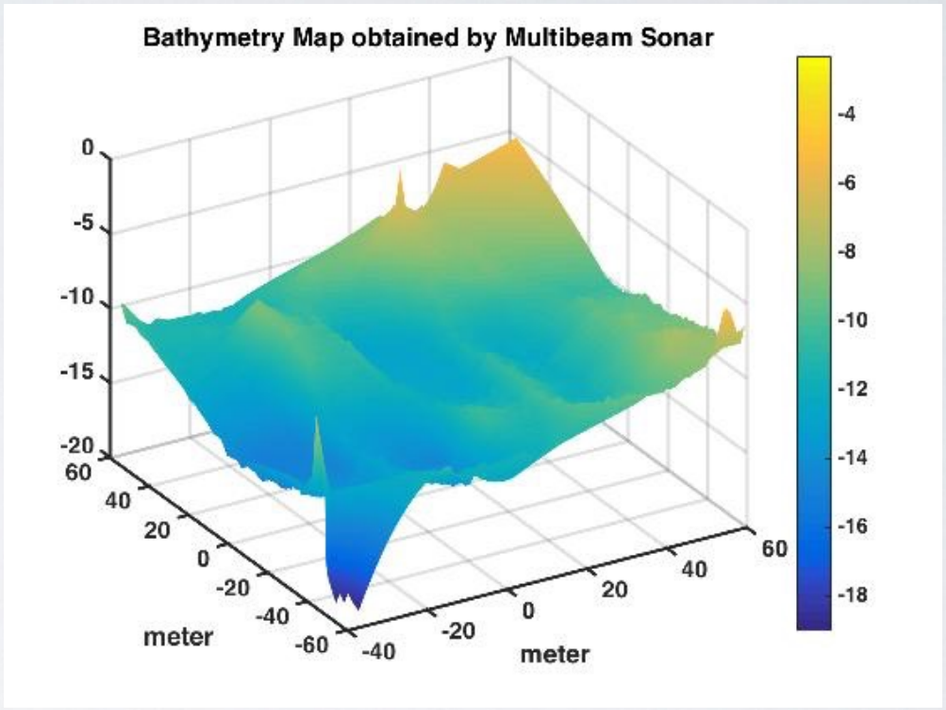
Autonomous underwater vehicle (AUV)



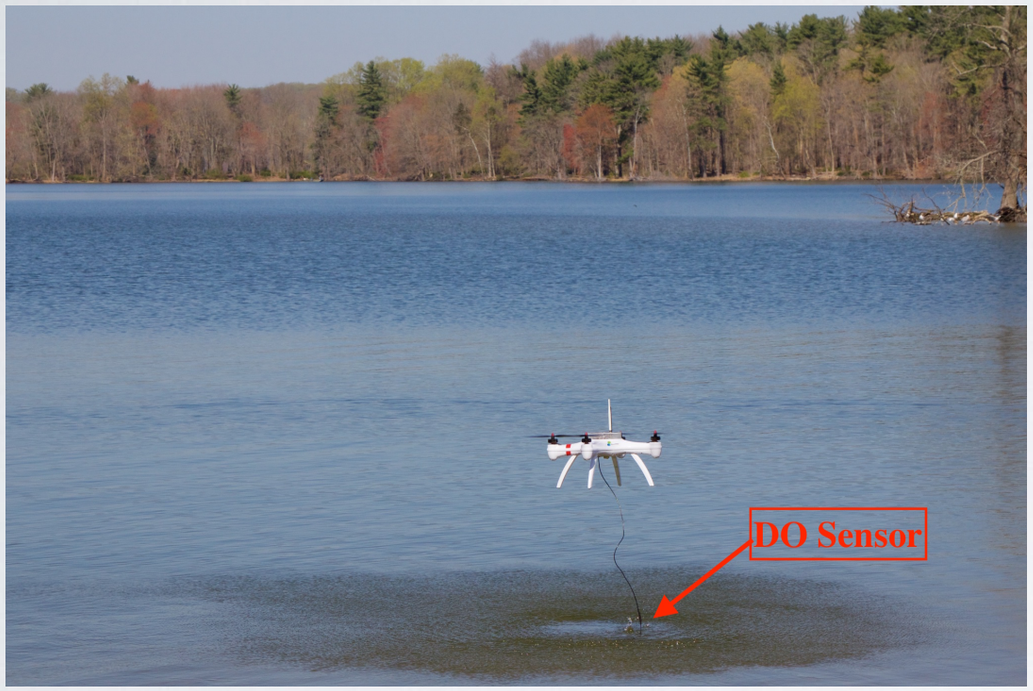


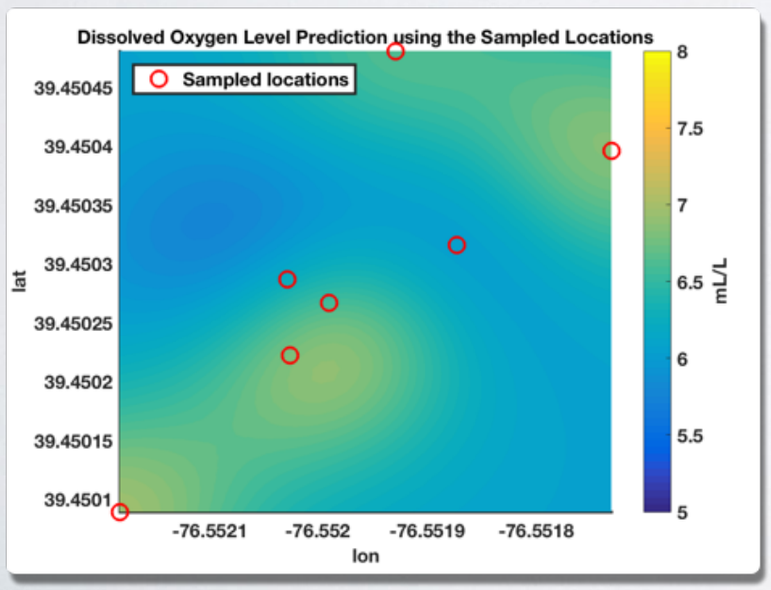


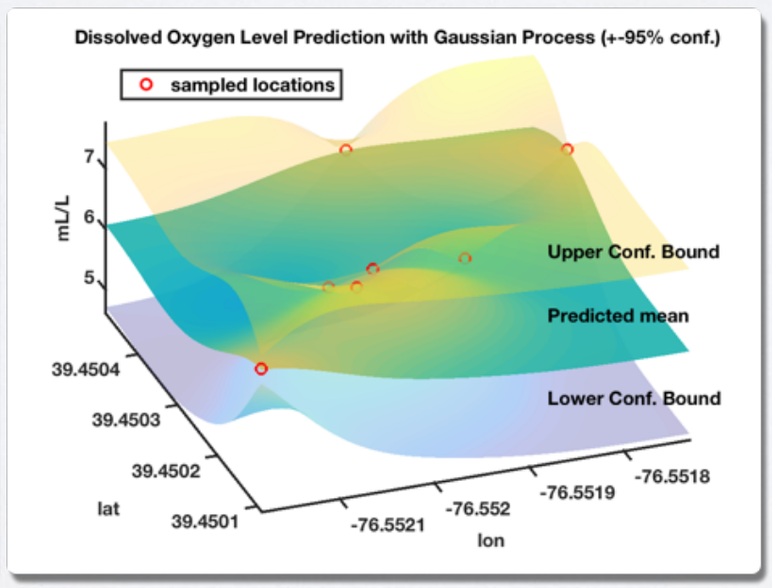
Unmanned surface vehicle (USV)



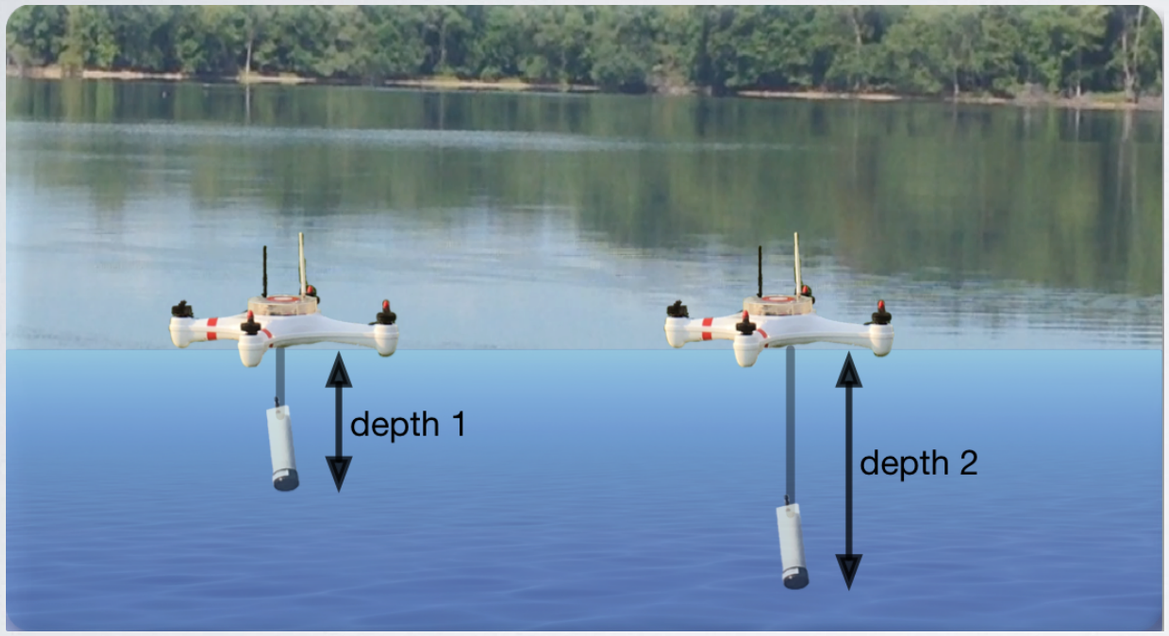
unmanned aerial vehicle (UAV)

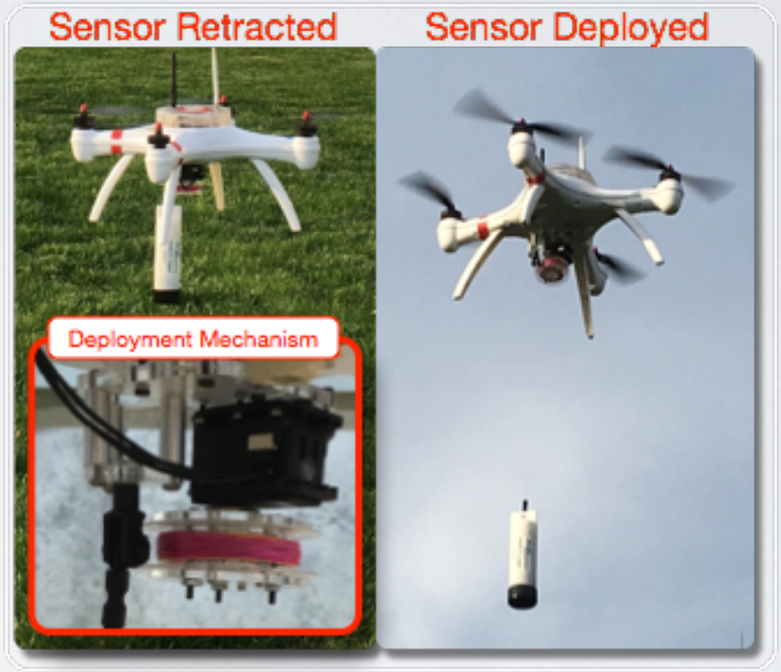






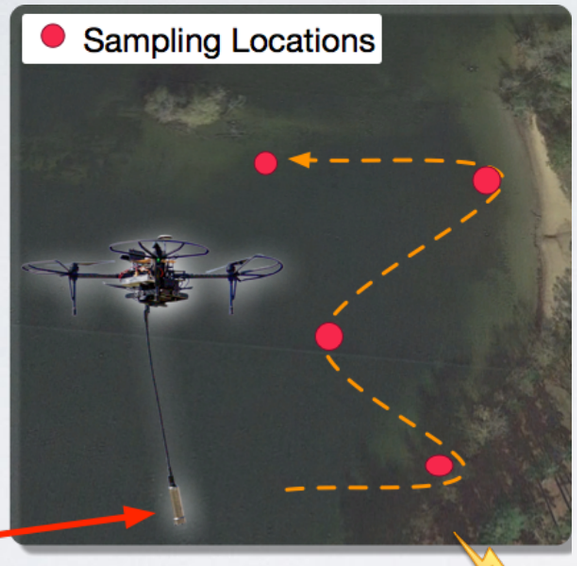
water column sampling with uav (work in progress…)



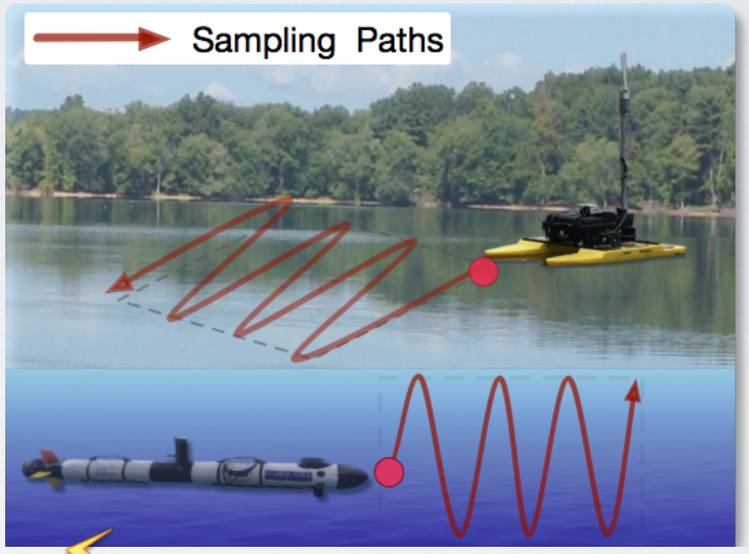


Mission Scenario …

With high navigational speed, the UAV is able to provide point-based sensing over a large mission area.

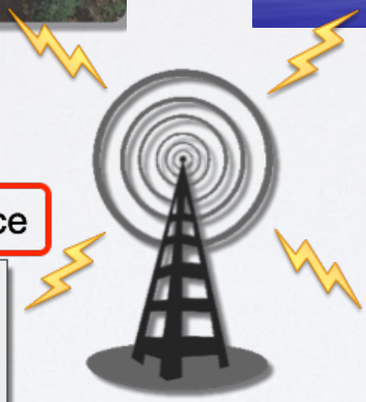


Water quality sensor



Both the AUV and USV can perform high resolution sampling and sensing along the trajectories in both spatio and temporal scale.

Remote operation from the office



Remote operation at the field

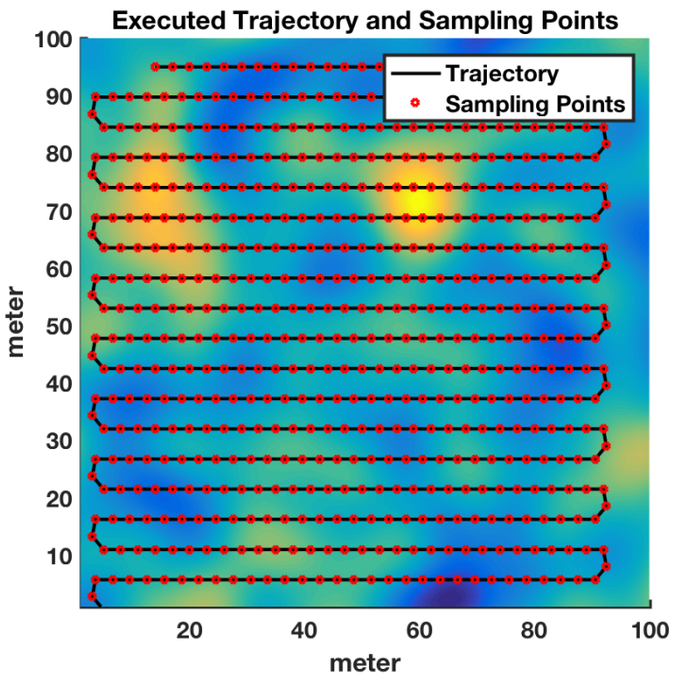
Computational intensive modeling can be performed off-board, either onsite by a computer on the shore, or offsite by clusters in the office.

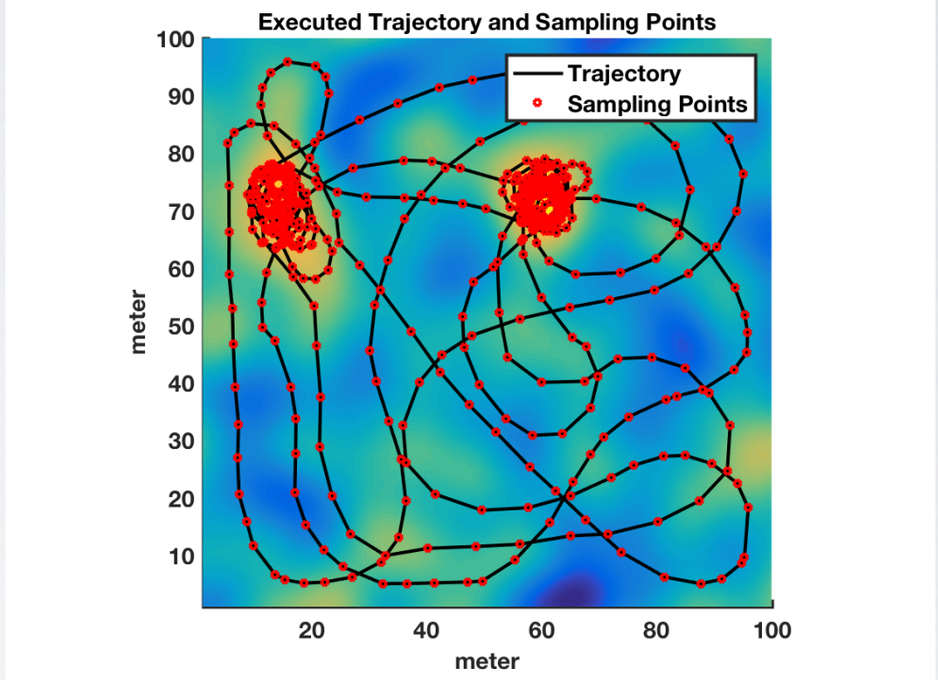
model driven

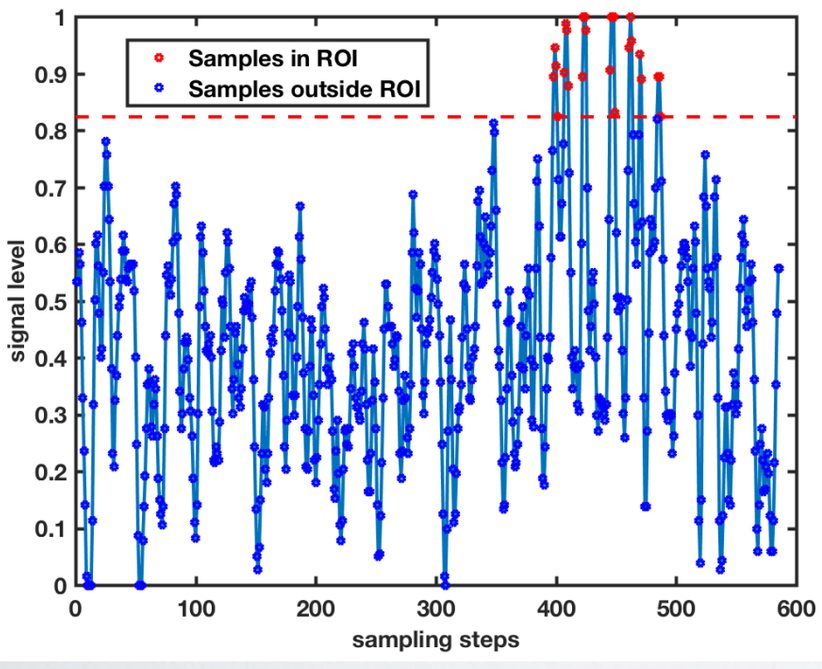
adaptive sampling

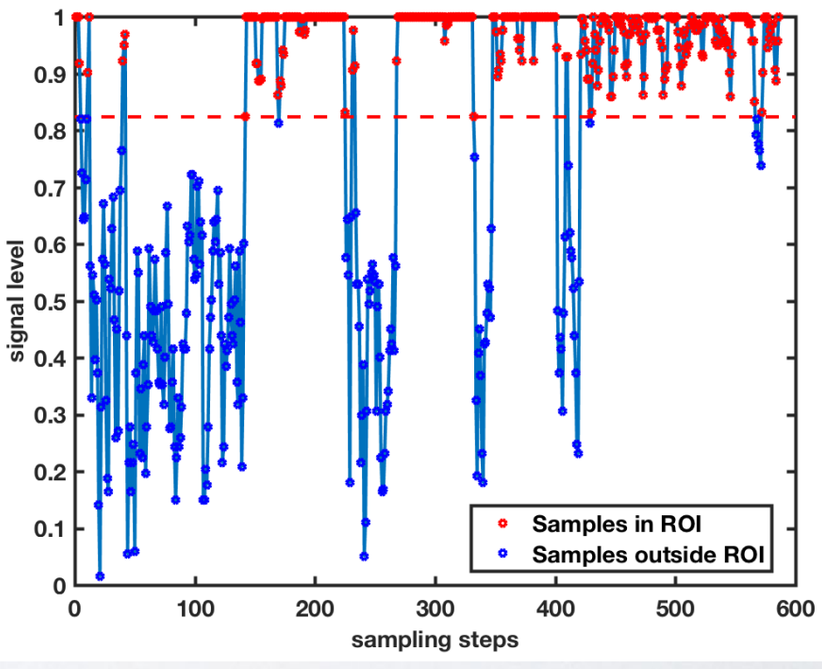
model driven Adaptive Sampling

advantages of adaptive sampling

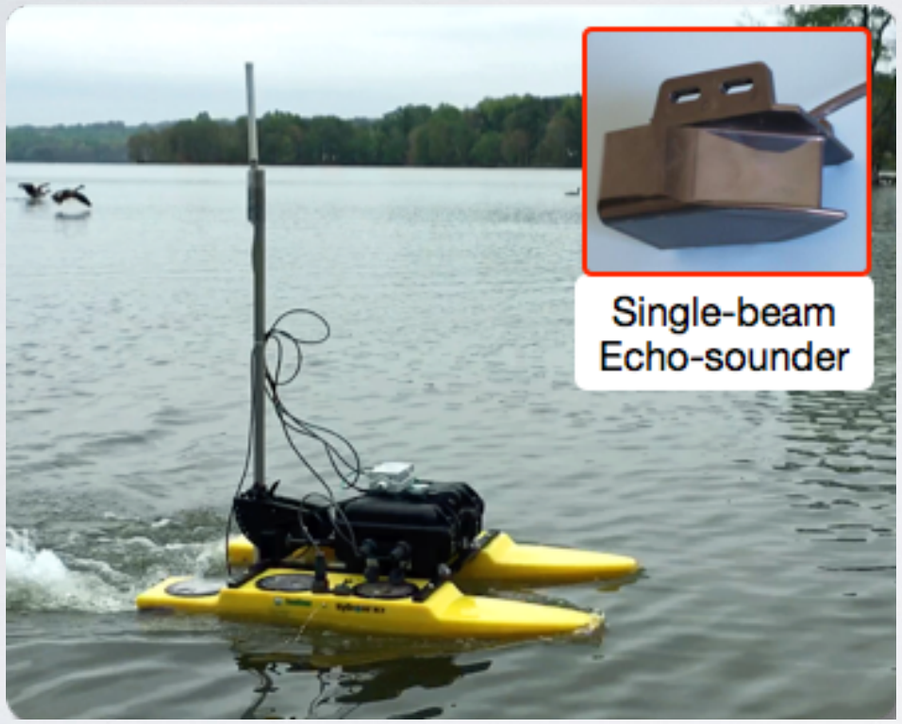


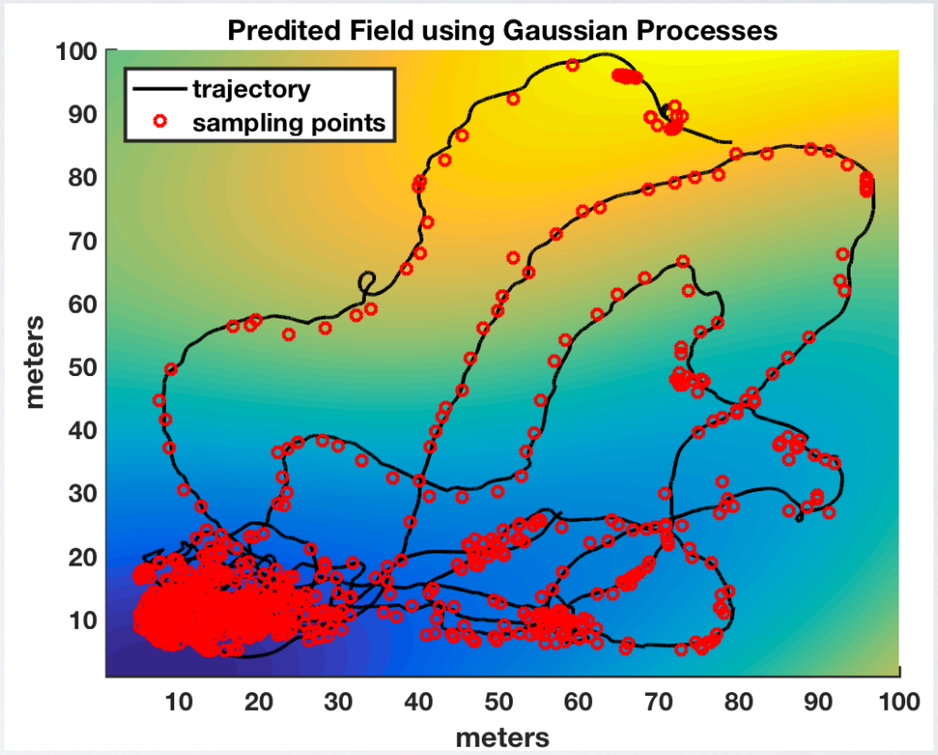


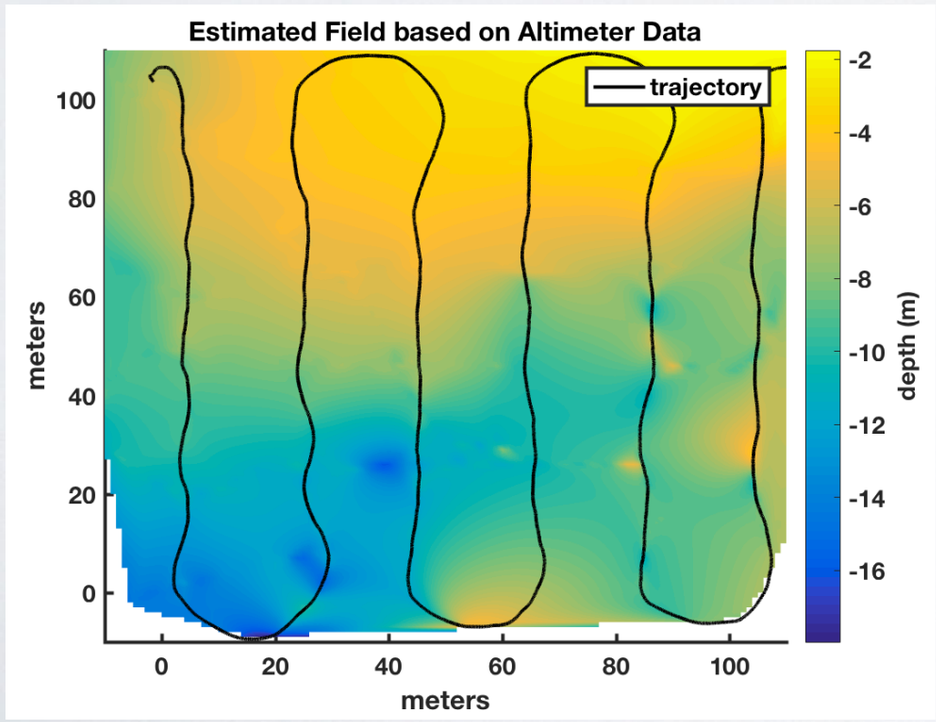


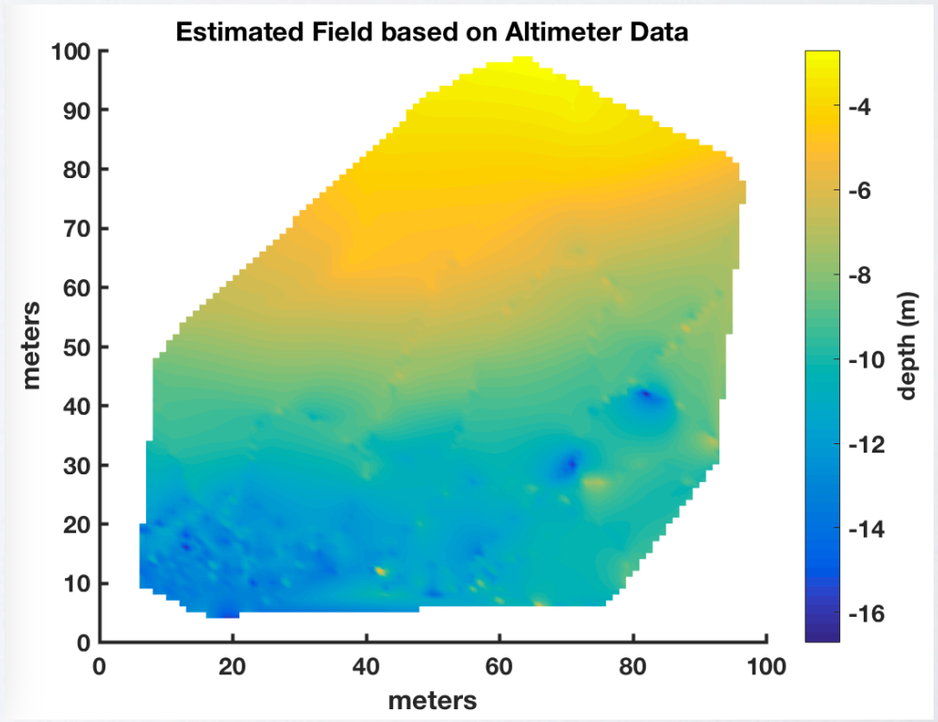


bathymetry survey









NEXT STEPS

- Focus on hypoxia-related nitrate sensing
- corporation of environmental dynamics into the modeling process
- Input from domain experts: engage environmental scientists, modelers

JHU Team

Paul Stankiewicz

William Tan

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Thank you