

PROGRESS REPORT

Project: **The Alliance for Coastal Technologies (ACT):** National-Scale Efforts Toward Verification and Validation of Observing Technologies

Grant No. **NA11NOS0120037**

Reporting Period: 10/1/11-9/30/12

Project Summary:

The Alliance for Coastal Technologies (ACT, www.act-us.info) is a collaborative partnership of academic institutions, state and federal resource managers, and private sector companies dedicated to fostering the development and adoption of effective and reliable sensors and sensor platforms for environmental monitoring and long-term stewardship of coastal and ocean resources. ACT seeks to achieve progress towards our goals to: (a) rapidly and effectively transition emerging technologies to operational use; (b) maintain a dialogue among technology users, developers, and providers; (c) identify technology needs and novel tools and approaches to meet those needs; (d) document technology performance and potential; and (e) provide U.S. IOOS with information required for the deployment of reliable and cost-effective networks. ACT pursues these goals through a three-pronged strategy of: (a) verification and validation of sensors and platforms for coastal and ocean observing systems through Technology Evaluations in different environments, utilizing both field experiments and laboratories to recreate environmental conditions; (b) capacity-building through Technology Workshops that involve researchers, manufacturers, users, regulators, and facilitators; and (c) knowledge exchange through an Information Clearinghouse and Technology Database that connects users with technology suppliers worldwide, presenting a forum to explore instrumentation options, and ultimately to share knowledge and experience, and exchange best practices. A unifying principle among these core activities is collaboration between technology/knowledge producers and users to provide input to ACT at every step of each process—from documenting national and regional needs, selecting sensor classes for evaluation and topics for workshops based on established regional priorities, to end-user application of new information.

Based on the findings of a recent Program Evaluation, and recommendations from our Board of Directors, ACT is adopting a theme-based approach that focuses our current suite of products and services, and new follow on activities, on specific priority topic areas. Climate variability is a main theme area for IOOS and the Regional Associations, with ocean acidification of particular interest to the RAs, IOOS, NOAA and diverse stakeholders from aquaculture operators to coral reef managers. The continual production of anthropogenic carbon dioxide from the burning of fossil fuels is increasing CO₂ gas in the atmosphere and, by absorption to the ocean, acidifying surface waters around the world. Ocean acidification has become one of the most significant and urgent issues facing ocean resource harvesters and managers. Monitoring the open ocean and the coastal oceans for CO₂ and pH levels will become paramount in assessing impacts and developing regulatory criteria, both nationally and internationally.

There are three important reasons for sustained, in situ measurements of pCO₂ from coastal moorings. The first is to evaluate whether coastal areas are functioning as a source or sink of atmospheric CO₂. Coastal areas are expected to be vulnerable to climate change, and this potential impact has direct consequence on managing CO₂ as a pollutant in the 21st century. High frequency temporal and spatial measurements of pCO₂ will provide some understanding of the fluxes, their variability and forcing parameters. The second reason for continuous monitoring of pCO₂ is to understand changes in saturation state of the water with respect to carbonate minerals and its impact on the health of calcifying organisms and communities (e.g., planktonic foraminifera, coral reefs, and oyster reefs). Surface pCO₂ measurements in conjunction with direct measurements of one other parameter of the marine CO₂ system (pH, TA or total DIC) can be used to calculate saturation state (for calcite and aragonite). The third important use of continuous monitoring is the direct measurement of net community production in shallow waters, which provides further understanding of how the carbon cycle is affected by climate change parameters such as temperature and pH. Changes in pCO₂ can occur on time-scales ranging from hourly, to seasonal and inter-

annual. All of these parameters are potentially being altered by CO₂ fluxes and progressive ocean acidification. Thus, it is vital to further promote, develop and improve measurement capabilities for seawater pCO₂ and pH.

In 2005, ACT held a workshop focused on measurements of Dissolved Inorganic Carbon (DIC) parameters to spur the use of pCO₂ and pH sensors for coastal applications. This workshop was followed by two distinct ACT Technology Demonstrations of in situ pCO₂ instruments; one series of laboratory tests and short term (one month) field deployments in Puget Sound, Washington, and a coral reef in Kaneohe Bay, Hawaii, and the second long-term (eight months) field deployments in the cold waters of Resurrection Bay, Alaska. We propose to continue efforts in this important theme area by focusing most of Year 2 activities around technologies for monitoring and understanding ocean acidification in coastal waters, including initiating an ACT Technology Verification of in situ pH sensors, a pCO₂ and pH sensors Design Requirement Workshop, and pH sensor Training Exercises.

Modified Scope of Work:

ACT's proposed Year 2 Work Plan included the following tasks for sustaining core technical functions and efforts addressing instrumentation needs for monitoring and understanding ocean acidification and its impacts on coastal waters.

I. Ocean Acidification

- A. *Working group on measuring pCO₂.* As a follow on to the second ACT Technology Demonstration of pCO₂ sensors, we propose to work with our Technical Advisory Committee to analyze and synthesize the fundamental results of these two Technology Demonstrations. The product of this working group will be the submission of manuscript to a peer-reviewed journal addressing considerations for the use of in situ pCO₂ instruments in coastal waters. This publication will not discuss the performance of the instruments tested (individual ACT reports will be released), but rather provide the community with lessons learned from our extensive work in this area. This effort will involve Drs. Atkinson (UH), Winsor (UAF), Mathis (UAF), Johengen (UM), Tamburri (CBL) and other ACT support staff.

The current pCO₂ Technical Advisory Committee includes Drs. Eric DeCarlo, University of Hawaii; Allan Devol, University of Washington; Andrew Dickson, Scripps Institute of Oceanography; Burke Hales, Oregon State University; Arne Kortzinger, Leibniz Institute of Marine Sciences (Germany); Jan Newton, University of Washington; Chris Sabine, NOAA-PMEL; Rik Wanninkhof, NOAA-AOML. Additional members will be brought on as needed.

- B. *pH Protocols Workshop.* As part of the continuing process of evaluating the performance of in situ pH sensors, ACT will hold a protocol workshop. The ACT pH Technology Advisory Committee, Lead PI, Chief Scientist, Technical Coordinators, QA/QC Coordinator, and representatives from each of the six companies that have applied to participate in this ACT Technology Verification, will gather for two days to discuss and draft a Verification Plan based on the recommendations of the Technical Advisory Committee and a community Needs and Use Assessment (completed in 2011). This workshop will result in a final, agreed to protocol for how the subsequent laboratory and field testing will be conducted, including timelines, a quality assurance plan, and data reporting format. The workshop will be held in Ann Arbor, MI and involve Drs. Atkinson (UH), Johengen (UM), Tamburri (CBL) and other ACT support staff.

The current pH Technical Advisory Committee includes Drs. Andrew Dickson, Scripps Institute of Oceanography; Burke Hales, Oregon State University; Chris Sabine, NOAA-PMEL; Rik Wanninkhof, NOAA-AOML; Robert Byrne, University of South Florida; Kenneth Pratt, National Institute of Standards and Technology; Scott McLean, Ocean Network Canada; Dwight Trueblood, NOAA-NERRS; Libby Jewett, NOAA-OA. Additional members will be brought on as needed.

- C. *Initiate Testing of pH Sensors.* Based on the final Test Protocols, ACT will conduct a portion of the planned testing in the laboratory and/or the field. It is unlikely that the complete suite of evaluations can

be completed with the current funding available. Therefore the pH Sensor Technology Verification will continue into 2013, with Year 3 support. Locations, resources, and personnel involved in these tests are to be determined but we anticipate involving/funding experts in the field and selected IOOS Regional Associations to support Drs. Atkinson (UH), Johengen (UM), Smith (MLML), Tamburri (CBL) and other ACT staff.

- D. *pH Sensor Training*. In conjunction with Year 2 laboratory and/or field testing, ACT will offer one to two day training exercises on the use of in situ pH sensors. The training will be open to all interested parties and will include lectures by subject experts on the science of ocean acidification and hands-on demonstrations of the various instruments being evaluated as part of the ACT Technology Verification. Hands-on demonstrations will be conducted by company representatives and include instrument set up, calibration, deployment, maintenance, data management, use of software, etc. Training exercises will involve Drs. Atkinson (UH), Johengen (UM), Smith (MLML), Tamburri (CBL) and other ACT support staff.
- E. *In Situ pH and pCO₂ Monitoring Design Requirements Workshop*. Based on input from the NOAA Ocean Acidification program, ACT Technical Advisory Committee, and related ocean acidification efforts (e.g., C-CAN), ACT will hold a workshop on the specific pCO₂ and pH instrument design requirements for applications in aquaculture, coral reef management, and the IOOS RAs. The workshop will bring together 20 to 25 technical staff from these three groups, with the manufacturers of pCO₂ and pH sensors (8 to 10 companies), to discuss and document specific operational requirements in areas such as: instrument accuracy, precision and range; physical connections and power requirements; calibration and maintenance cycles; data format and management, etc. This workshop will be held in the Washington DC area and involve Drs. Atkinson (UH), Johengen (UM), Tamburri (CBL) and other ACT support staff.

II. Oil Spills

- F. *Working group on measuring hydrocarbons*. As a follow on to the recently completed ACT Technology Verification of hydrocarbon sensors, we propose to work with our Technical Advisory Committee to analyze and synthesize the fundamental results of this Verification. The product of this working group will be the submission of manuscript to a peer-reviewed journal addressing considerations for the use of in situ hydrocarbon sensors. This publication will not discuss the performance of the instruments tested (individual ACT reports will be released), but rather provide the community with lessons learned and discuss limitation of using optical instruments for detecting subsurface oil. This effort will involve the ACT Hydrocarbon Technical Advisory Committee, Drs. Johengen (UM), Smith (MLML), Tamburri (CBL) and other ACT support staff.

The current Hydrocarbon Technical Advisory Committee includes Drs. Brian Bergamashi, USGS; Emmanuel Boss, University of Maine; Paula Cobble, University of South Florida; Kjell Gundersen, University of Southern Mississippi; Paul Kepkay, Bedford Institute of Oceanography (Canada); Scott Pegau, Alaska Oil Spill Recovery Institute; Michelle Woods, NOAA-AOML. Additional members will be brought on as needed.

III. Programmatic Activities

- G. *Outreach and Community Involvement.* We plan to continue some fundamental outreach activities, including participation in national conferences, symposia or related workshops. We will also work with NFRA and the RAs to solicit RA input on priorities for ACT Technology Evaluations and Workshops themes, to coordinate outreach activities with the RAs to efficiently/effectively engage overlapping stakeholders, and to promote ACT and RA collaborations. Finally, we will continue communications with, or support of, NDBC, CO-OPS, USACE, NWQMC, and Quality Assurance of Real-Time Ocean Data (QARTOD) and will continue joint activities with other related agencies including NIST, MARAD, USCG and EPA. Drs. Tamburri (CBL), Atkinson (UH), Winsor (UAF), Smith (MLML), Johengen (UM), and other ACT support staff.
- H. *Technology Information Clearinghouse.* Basic website and Technology Database activities will continue but reductions in funding will only allow for periodic updates and maintenance. We will continue to post all Technology Evaluation and Workshop final reports (as download PDF files), related news items and web links, and basic program information on the public ACT website. The searchable Technology Database will also be maintained and expanded, where possible. We will also continue our collaboration with the NWQMC National Environmental Methods Index (NEMI, www.nemi.gov) on the integrated Methods of Environmental Measurement and Observation (MEMO). The MEMO web portal allows for searches of specific environmental parameters that result in listings and documentation on both standard methods and commercial instruments to quantify/measure the parameter of interest. Drs. Tamburri (CBL) and ACT support staff will carry out these activities.
- I. *Program Administration.* ACT will maintain required routine governance responsibilities and management functions and schedules. Dr. Tamburri (CBL) will continue to coordinate core functions and guide program-wide activities, such as partnerships with other agencies and linkages with the coastal management community, with support from the other funded PIs. Monthly PI conference calls and one annual organizational meeting will continue. Limited funding will only allow for one half-day videoconference in July 2012 and one face-to-face Board of Directors in February 2013, in Corvallis, OR. However, we will also facilitate four to six 1-hour conference calls, dependent on need.

Revised ACT Milestone:

Functional Area / Tasks (June 1, 2012 – May 31, 2013)	J	J	A	S	O	N	D	J	F	M	A	M
A. Working group on measuring pCO_2	X	X	X	X	X	X						
B. pH Protocols Workshop	X											
C. Initiate Testing of pH Sensors				X	X	X						
D. pH Sensor Training				X	X	X						
E. In Situ pH and pCO_2 Design Requirements Workshop										X		
F. Working group on measuring hydrocarbons			X	X	X	X	X	X				
G. Outreach and Community Involvement	X	X	X	X	X	X	X	X	X	X	X	X
H. Technology Information Clearinghouse	X	X	X	X	X	X	X	X	X	X	X	X
I. Program Administration	X	X	X	X	X	X	X	X	X	X	X	X

3) Progress and Accomplishments

The following table provides a comparison of actual versus proposed accomplishments with the goals and objectives for the period, and reasons why objectives/goals were not met (if needed).

Technology Related Tasks		
Activity	Purpose	Status
Working Group on Measuring pCO ₂	Provide the community with lessons learned from our extensive work in this area and to publish a broad synthesis on in situ measures of pCO ₂ .	<u>Testing Completed / Behind Schedule.</u> We are now trying to retrieve and analyze data from the final set of field tests in Alaska and we are working with the pCO ₂ Technical Advisory Committee and participating vendors to decide on how to proceed with shortened assessments of instrument performance.
pH Protocol Workshop	Agree to protocol for how the subsequent laboratory and field testing will be conducted, including timelines, a quality assurance plan, and data reporting format.	<u>Completed.</u> The workshop was held in Ann Arbor, MI in June 2012.
Initiate Testing of pH Sensors	Begin the verification and validation of commercially available pH sensors through extended laboratory mesocosm deployment tests.	<u>Ongoing / On Schedule.</u> The laboratory test facility and equipment at HMBI has been set up and tests will begin the first week of December 2012.
pH Sensor Training	Build community awareness and capacity on in situ instrumentation for measuring pH with lectures by subject experts on the science of ocean acidification and hands-on demonstrations of instrument set up, calibration, deployment, maintenance, data management, use of software, etc.	<u>Ongoing / Postponed.</u> To take advantage of an opportunity to connect with the target community of technology users, the training exercise has been postponed. However, a proposal to hold the pH Sensor Training as a workshop at the upcoming CERF Conference in San Diego, CA, in November 2013, has been accepted and planning is underway to complete this task.
In Situ pH and pCO ₂ Monitoring Design Requirements Workshop	Discuss and document specific operational requirements in areas such as: instrument accuracy, precision and range; physical connections and power requirements; calibration and maintenance cycles; data format and management, etc.	<u>Ongoing / On Schedule.</u> Still in early planning stages.
Working group on measuring hydrocarbons	Provide the community with lessons learned from our extensive work in this area and to publish a broad synthesis that discusses in situ measures of hydrocarbons and limitation of using optical instruments for detecting subsurface oil.	<u>Ongoing / On Schedule.</u> Still in the data analysis and interpretation stage.

Outreach and Community Involvement		
Activity	Purpose	Status
World Ocean Council Smart Ocean/Smart Industry Workshop, Paris, France	Build awareness and identify community needs.	Completed. December 12 – 13, 2011
MARACOOS Annual Meeting, Washington, DC	Build awareness, identify community needs and develop collaborations.	Completed. December 15 – 16, 2011
Regional IOOS Spring Meeting, Silver Spring, MD	Progress reports and plan for the future.	Completed. February 28 – March 1, 2012
IOOS US Animal Telemetry Network Meeting, Washington, DC	Build awareness, partnerships and collaborations with IOOS Regional Associations.	Completed. March 15 – 16, 2012
SPIE Ocean Sensing and Monitoring IV Conference, Baltimore, MD	Build awareness and identify community needs.	Completed. April 25 – 28, 2012
8 th National Monitoring Conference, Portland, OR	Build awareness and identify community needs.	Completed. April 30 – May 4, 2012
IMO London Protocol Workshop, Jeju, Korea	Build awareness and identify community needs.	Completed. May 14 – 18, 2012
Meetings with NOAA Office of Coast Survey and IOOS, Solomons, MD	Build awareness, identify community needs and develop collaborations.	Completed. May 30, 2012
Briefing to the IWG-OP	Build awareness, identify community needs and develop collaborations.	Completed. August 14, 2012
Meetings with BEOM and BSEE Herndon, VA	Build awareness and explore how ACT and IOOS can support BEOM and BSEE activities.	Completed. September 18, 2012
Participated in the JERICO Forum for Coastal Technologies workshop during Sea Tech Week in Brest, France	Discussions on ACT Technology Evaluations, JERICO sensor selections, and joint activities.	Completed. October 10-12, 2012
IOOS Summit, Herndon, VA	Accepted Community White Paper and Led of Breakout Session on Emerging Technologies .	Completed. November 13-16, 2012

Technology Information Clearinghouse		
Activity	Purpose	Status
Manage, maintain, and update interactive on-line database.	Provide ocean technology community a single resource for identifying available technology options; facilitate coastal observing technology providers and users to match needs in a virtual “marketplace” environment.	Ongoing / On Schedule. ACT website includes 40 Technology Evaluation reports, 38 Technology Workshop reports, and over 4,000 instrument listing (from over 300 international companies) in the searchable Technology Database. ACT database has also been harmonized and linked with National Environmental Methods Index (NEMI, through USGS and NWQMC) and the new web portal called Methods of Environmental Measurement and Observation (MEMO), has now been released to the public. All ACT reports, including Test Protocols, Technology Evaluations, Workshops, and Needs and Use Assessments, will continue to be searchable and available as download pdf files through the website.

Program Administration		
Activity	Purpose	Status
ACT Board of Directors and Partner meeting, NOAA IOOS Office, Silver Spring, Maryland	Progress reports, prioritizing activities and strategic planning.	Completed / Modified, first meeting February 9, 2012, second meeting replace with conference call because of limited travel funds.
ACT Partner conference calls	Coordination, progress reports, and planning.	Ongoing, first Thursday of each month.
ACT Advisory Council conference calls	Community input and selection of themes and activities.	Ongoing

4) Personnel and Organizational Structure and Program Administration

ACT is going through a reorganization and restructuring in response to: (a) guidance by the ACT Board of Directors, (b) reductions in funding available for program base-support, and (c) importance of shifting focus of ACT products and services more directly toward specific needs of the U.S. Integrated Ocean Observing System. The goals of this reorganization are to become more cost effective and efficient, expand products and services and broaden program expertise by increasing community involvement, while maintaining scientific credibility, impartiality, and data quality. Modifications to the program will be implemented over time and the most notable changes include:

- Moving to a thematic approach for activities that focus on topical technology issues for two to three year cycles. The process for selecting topics will be driven directly by IOOS and Regional Association needs.
- Increasing program efficiency, technical expertise and access to relevant resources by moving to a smaller Core Team that will be supported by three to five theme-based Associates and/or Test Centers. Associates and Test Centers will be selected from existing ACT Partners, national subject matter experts and institutions, and the IOOS Regional Associations.
- Allocating funding amongst Core Team, active Associates/Test Centers, and theme specific experts, based on the needs of specific tasks and activities.
- Extending products and services for each theme beyond current activities to address the broader suite of technology user and provider needs and to help support all the technology transition steps identified in the draft IOOS Sensor Technology Innovation Program.

5) Budget Analysis

Actual expenditures have been incurred in accordance with the spending plan provided in the UMCES application. It is not anticipated that any budget modifications will be needed during the next reporting period. All financial reports for this award are up to date.