Water Quality Sensors
Where are we, where are we going, and why aren’t we there yet?

Mario Tamburri
University of Maryland
Center for Environmental Science
Alliance for Coastal Technologies

ACT Priorities

- Transition emerging technologies to operational use rapidly and effectively
- Maintain a dialogue among technology users, developers, and providers
- Identify technology needs and novel technologies
- Document technology performance and potential
- Provide information required by IOOS for the deployment of accurate, reliable and cost-effective observing networks

ACT Services

- A third-party testbed for evaluating technologies
- A forum for capacity and consensus building
- An information clearinghouse for environmental technologies
Generic Testing Approach

燋 Types of Evaluations:
  • Performance Verification
  • Performance Demonstration

燋 Purpose:
  • Document performance under third party tests
  • NO certifications, recommendations, or comparisons

燋 Benefits:
  • Community engagement
  • Enhanced ability to identify appropriate technologies
  • Level playing field among manufacturers
  • Accelerated adoption of innovative technologies

燋 Credibility:
  • Objective testing
  • Skilled, trained personnel
  • Sound methodologies with statistical rigor
  • Transparency and comprehensive documentation
  • Rigorous QA/QC
ACT Partner Institutions

Arctic
- University of Alaska Fairbanks

Great Lakes
- University of Michigan Cooperative Institute for Limnology & Ecosystems Research

Pacific
- Moss Landing Marine Laboratories

Tropical
- University of Hawai’i

Atlantic
- University of Maryland Center for Environmental Science Chesapeake Biological Laboratory

Gulf
- University of South Florida College of Marine Science
Diverse Environments & Applications
Generic Testing Process
**Sensors – Where are we?**

- **DO Sensors (2004)** - Aanderaa (optode), Greenspan (galvanic cell), In-Situ (optode), YSI (Clark cell)
- **Chl-a Fluorometers (2005)** - bbe Moldaenke, Chelsea (2), Hydrolab, Turner (2), WET Labs, YSI
- **Turbidity Sensors (2006)** - Aquatec, In-Situ, McVan, WET Labs, YSI
- **Nutrient Analyzers (2007)** - American EcoTech, Satlantic, WET Labs, YSI
- **C-T Sensors for In Situ Salinity (2008)** - Aanderaa, Campbell, Falmouth, Greenspan, In-Situ, RBR, Rockland, YSI
- **pCO₂ Analyzers (2009/2010)** - Contros, NOAA/PMEL (Battelle), Pro-Oceanus, Sunburst, YSI
- **Hydrocarbon Sensors (2011)** - Aquatec, Chelsea (3), Hach, S:can, Turner Designs, and WET Labs
- **pH Sensors (2012)** - Aanderaa, Campbell, Idronaut, In-Situ, Satlantic, Sunburst, YSI
Nutrients Performance Demonstrations

Transitioning into operations

- Nitrate-Nitrite (mg/L) vs. Time
- Phosphate-P (uM) vs. Time
Salinity Performance Verifications

Mature ≠ reliable/accurate
pCO$_2$ Performance Demonstrations

- pCO$_2$ is important but complex

Graphs showing pCO$_2$ measurements over time.
Hydrocarbon Performance Verification

Are fluorometers the way to monitor oil spills?
ACT Program Evaluation – Where are we?

**PRIORITIES**
- Transition emerging new ocean-observation technologies to operational use rapidly, efficiently, & effectively.
- Maintain a continuing dialogue among operational technology users, technology providers, & the R&D community.
- Identify technology needs, find new technologies, & document technology potential.
- Quantitatively evaluate alternative technologies & provide the IOOS agencies with information required for the deployment of a cost-effective system of synergistic observing instruments.

**INPUTS**
What do we need to achieve our goals?
- People: Headquarters Staff (Dir, Cs; MS, PM; Con) Partner Institutions (PI, TC.,) Stakeholder Council, External Partnerships, e.g., NOAA
- Funds: NOAA ($3 million) In-kind contributions by Partners
- Infrastructure: Office Field (Docks, ships, equipment) Laboratory (Equipment)

**OUTPUTS**
Activities Reach
- Outreach: Stakeholder, Alliance Member activities Publications, other print materials Web-based
- Technology Brokering: Technology clearinghouse
- Technology Brokering: Customer needs assessments
- Technology Evaluations: Demonstration Verification
- Capacity Building: Tech Workshop
- Technology Developers (R&D) Technology Vendors (Manufacturing)

**OUTCOMES**
Short Medium Long-term
A: Technology users use quality-assured, peer-reviewed test data about the performance of coastal observing technologies
b. Efficient & effective two-way communication & cooperation between key stakeholders
C: New communications networks used among key stakeholders
c. Science community transitions marine technology rapidly from R&D to sustained applications
D: Tech staffs of coastal mgmt agencies interact directly with companies & technologists
d. Developers use decision support tools that facilitate investment decisions
E: Users’ technology needs well defined, documented, & understood
e. Developers use decision support tools that facilitate investment decisions
F: Coastal mgmt & obs techs well trained in concepts / use of state-of-the-art sensor tech

**GOAL**
Better understand, predict, & manage coastal environments
ACT Program Evaluation – Where are we?

<table>
<thead>
<tr>
<th></th>
<th>Technology Developers &amp; Providers</th>
<th>Technology Users</th>
<th>Tech Info Providers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Private</td>
<td>Public</td>
<td>Private Corps</td>
</tr>
<tr>
<td>Relevancy</td>
<td>100%</td>
<td></td>
<td>&gt; 75%</td>
</tr>
<tr>
<td>Credibility, Objectivity</td>
<td>100%</td>
<td></td>
<td>&gt; 75%</td>
</tr>
<tr>
<td>Quality, Competency</td>
<td>100%</td>
<td></td>
<td>&gt; 75%</td>
</tr>
<tr>
<td>Usefulness</td>
<td>100%</td>
<td></td>
<td>&gt; 50%</td>
</tr>
</tbody>
</table>

- Blue: 100%
- Light blue: > 75%
- Light gray: > 50%
- Pink: < 50%
ACT Program Evaluation – Where are we going?

Current Activities

- Selection of Themes
- Technology Workshop
- Technology Database
- Needs and Use Assessments
- Capabilities Assessments
- Design Requirements
- Technology Evaluations
- Subject Matter Clearinghouse
- Standard Operating Procedures
- Technology Training
- Operational Deployment Testing

Potential Activities
Why aren’t we there yet?

- Limited resources
- Different requirements for different users
- Parameters and technologies are complex
- Nice to have but not must have