Tools Required for Coastal and Ocean Observing

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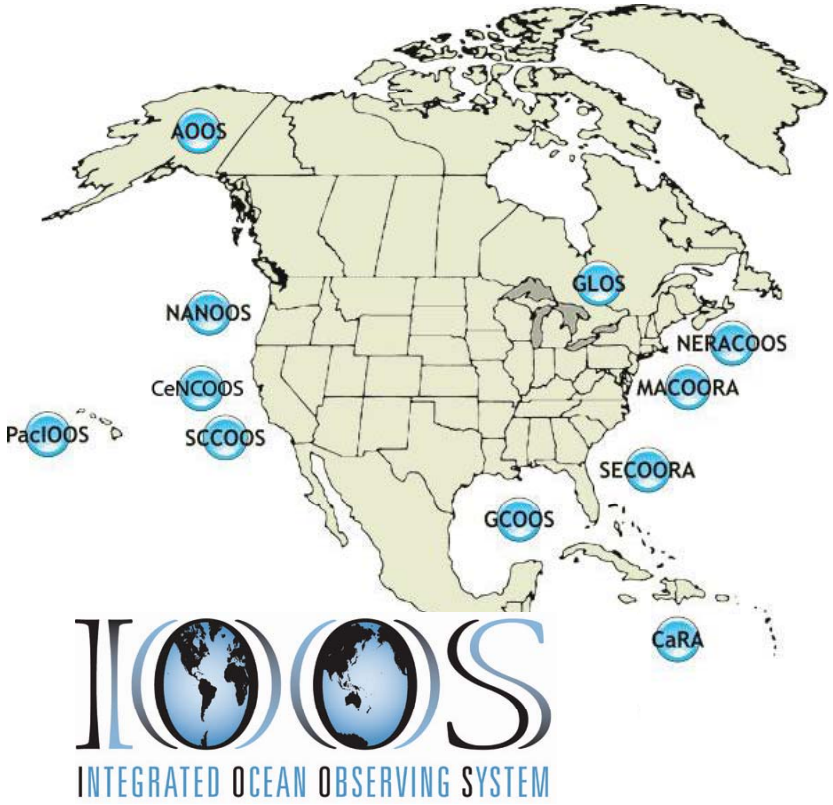
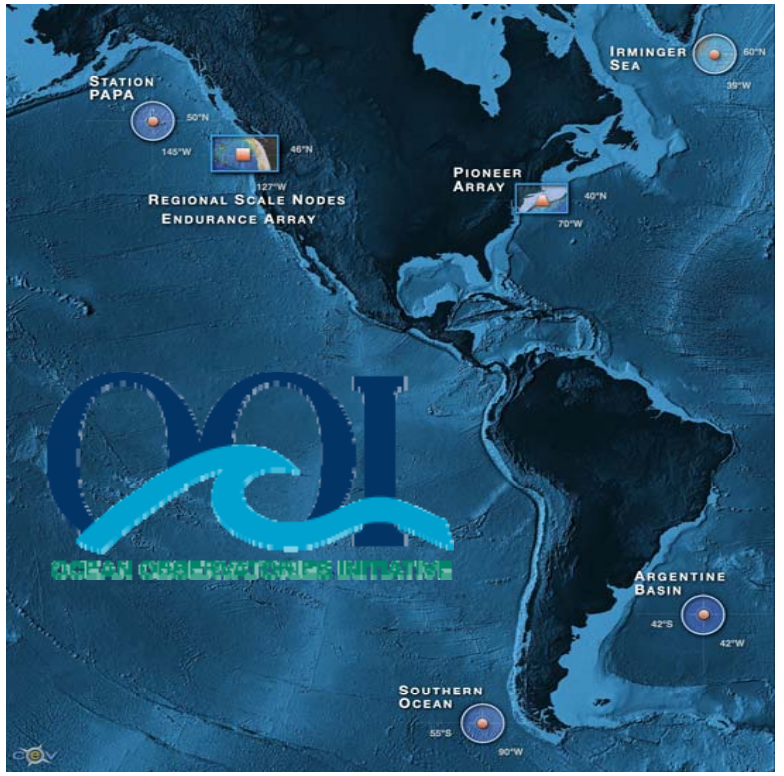
ALLIANCE FOR COASTAL TECHNOLOGIES

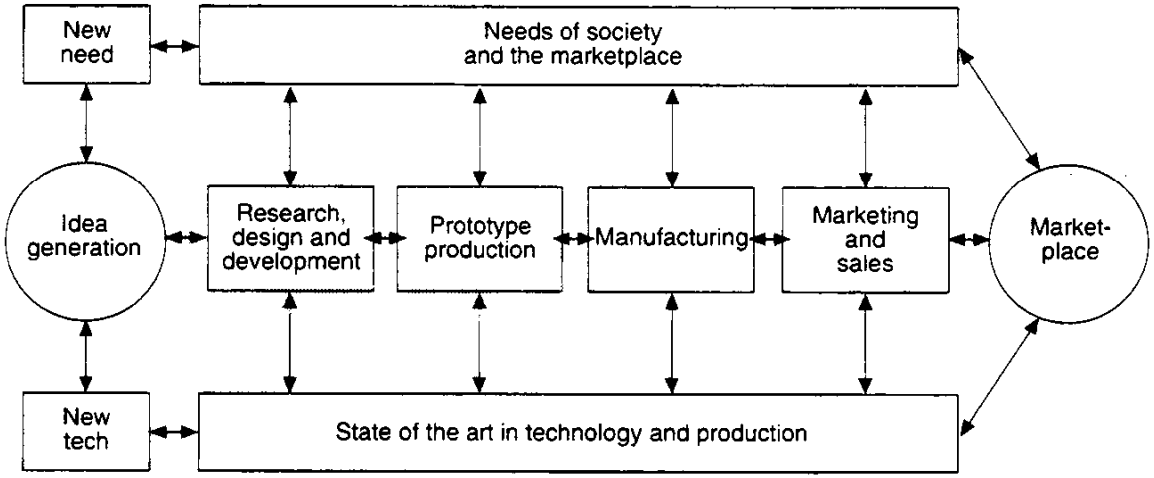
Coastal and Ocean Monitoring

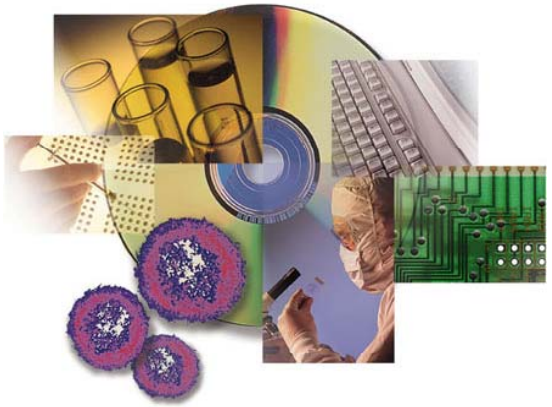
- **Dozens of local, state and federal monitoring efforts**
- **New national and international ocean observing efforts**

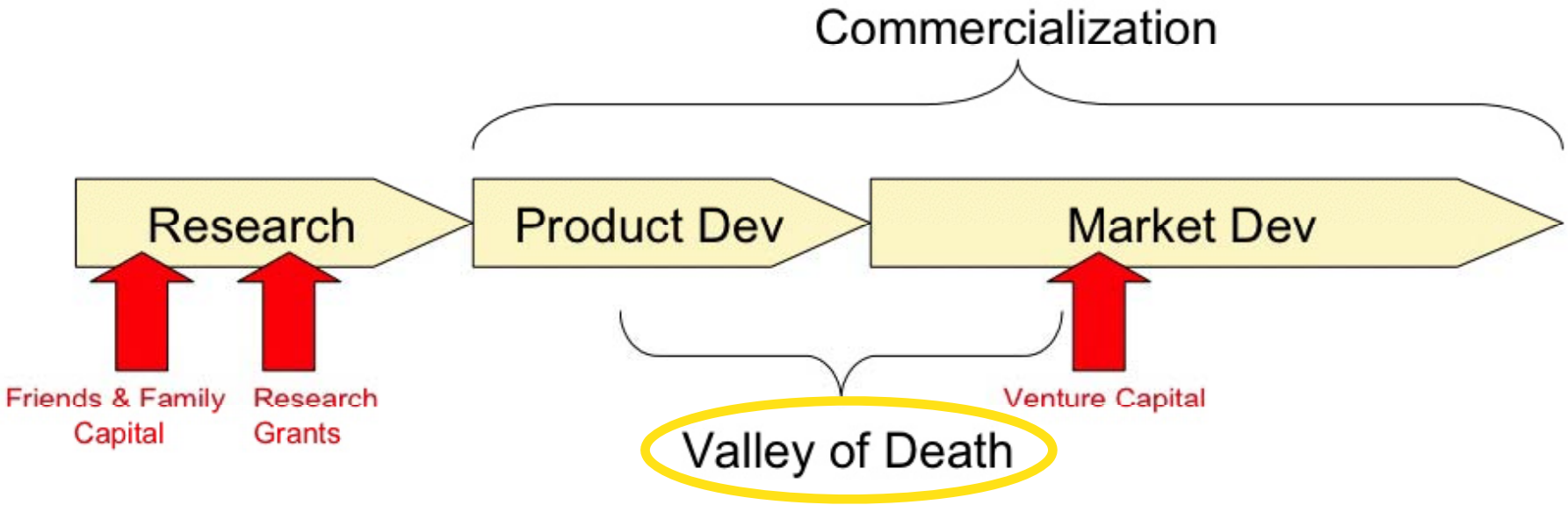




Innovation and Technology Transfer







De-Risk Technologies

***Nature*, May 2007**

"Novel observation technologies can often be error-prone."

Artefacts in ocean data hide rising temperatures

According to the myth — and a classic movie — Jason and his shipmates on the *Argo* suffered more than their fair share of reverses before bringing home the Golden Fleece. The international team of oceanographers working on the ambitious ARGO programme can surely sympathize. Instrumentation flaws have been discovered that undercut the programme's most striking finding to date. The problems have reinforced calls for caution when interpreting 'real-time' environmental data.

ARGO is an array of floats drifting freely around the oceans, 2,800-strong so far and still growing. Each float shuttles back and forth between the surface and the ocean depths measuring temperature and salinity, then sending data home via satellite when it is at the surface.

In 2006, data from the array led a team of scientists to the surprising conclusion that the world's oceans had cooled during 2003–05 — exceptionally warm years in terms of global surface temperature. The team published its findings in *Geophysical Research Letters*[1]. Such apparent cooling was seized on by people keen to highlight the uncertainties in forecasts of global warming[2].

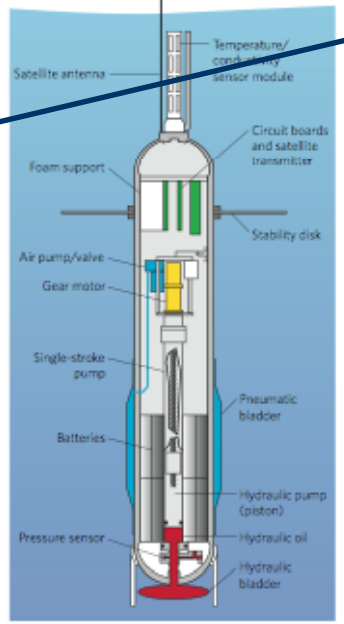
That cooling has now been shown to be an artefact. In some of the buoys — they are manufactured in separate batches — a software glitch caused the temperature and salinity data to be associated with the wrong depths. When the problem data are excluded from the analysis, the cooling trend drops below the level of statistical significance.

Novel observation technologies can often be error-prone. In 1997, for example, the discovery of a software problem involving NASA's TOPEX/Poseidon satellite forced a number of groups to lower previously published estimates of global sea-level rise[3]. And until three years ago, calibration problems with data retrieved from different satellites led to an apparently striking discrepancy between temperature trends at Earth's surface and in the atmosphere[4].

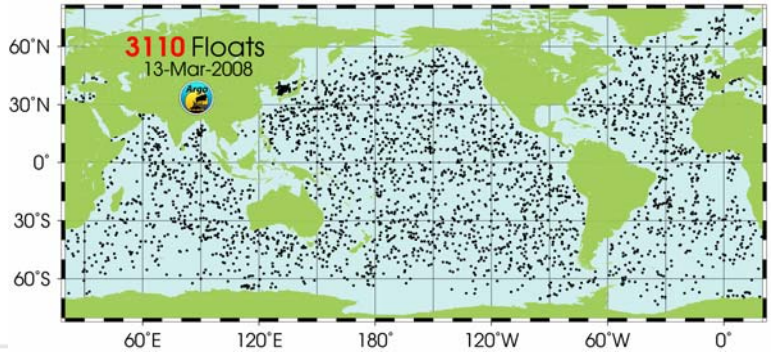
The ARGO problem is a reminder that rigid quality control is vital in such cases, says Keith Alverson, director of ARGO's parent agency, the Global Ocean Observing System at the United Nations Educational, Scientific and Cultural Organization in Paris. The ideal is to be able to compare a new analysis with an independent data stream, he adds.

The flaw occurred in a batch of floats fabricated at the Woods Hole Oceanographic Institution in Massachusetts. It was detected when the temperature profiles generated by ARGO were compared with historical data from the regions where the cooling seemed to be most pronounced.

The authors of the original report, led by John Lyman of the National Oceanic and Atmospheric Administration in Seattle, Washington, submitted a correction to *Geophysical Research Letters* on 9 April; this had not been published when *Nature* went to press. Apart from the spurious ARGO data, they report a newly discovered bias in temperature profiles from expandable bathythermographs (XBTs) that were also used for the analysis. Inexpensive XBTs have been a major data source for many oceanographic studies. The two problems concealed each other, says Josh Willis, an oceanographer at the Jet Propulsion Laboratory in Pasadena, California, and a co-author of the report: "When I first became aware of the problem I was really horrified."



The ARGO array of almost 3,000 floats measures ocean temperature and salinity worldwide.



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 the information required for deployment of reliable and cost-effective observing networks

ACT Services

- A forum for capacity and consensus building
- An information clearinghouse for coastal technologies
- A third-party testbed for evaluating coastal technologies

Capacity and Consensus Building

- **Technology Workshops**
- **Facilitate Plan Development**
- **Technology Training**
- **Needs and Use Assessments**
- **“Guide to…” documents**

Technology Workshops

Purpose:

- Review current state of technology
- Discuss limitations to current technologies and identify user needs
- Provide recommendations to ACT and the community
- Enhance connections between users and developers

Benefits:

- A forum for discussion among users, developers, and manufacturers
- All aspects of community involved in consensus building
- Establish collaborations/partnerships

Outcomes:

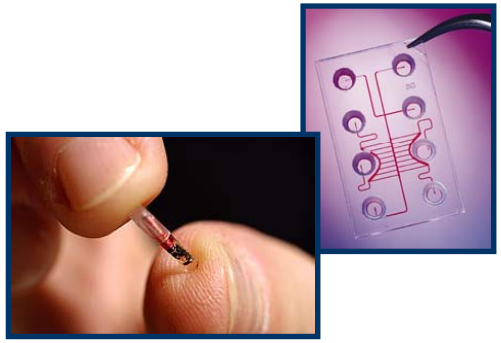
- Altered the way data is collected / instruments used
- Altered technology designs / features
- Generated funding opportunities
- Helped focus other ACT activities

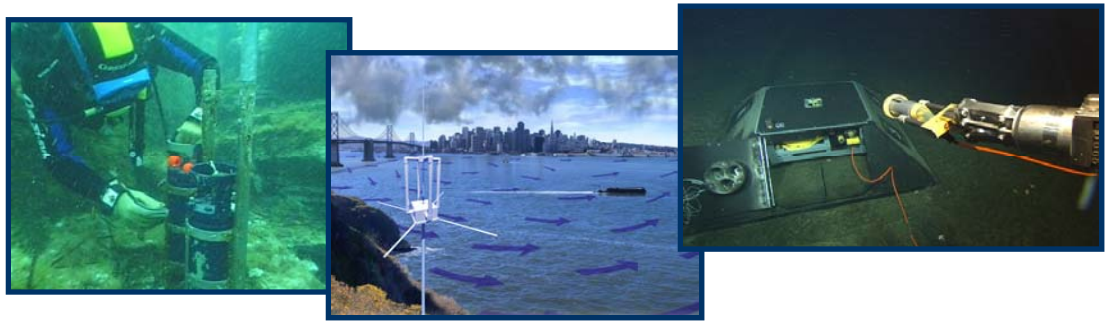
Past Workshops

- Biosensors for Harmful Algal Blooms
- Management Applications for AUVs and Gliders
- Surface Current Radar
- Rapid Identification of Coastal Pathogens
- Meteorological Sensors for Buoys
- Integrated Sensor Systems for Vessels of Opportunity
- Operational Dissolved Oxygen Measures
- Sensor Inter-Operability
- Hydrocarbon Sensors for Oil Spill Response

Upcoming Workshops

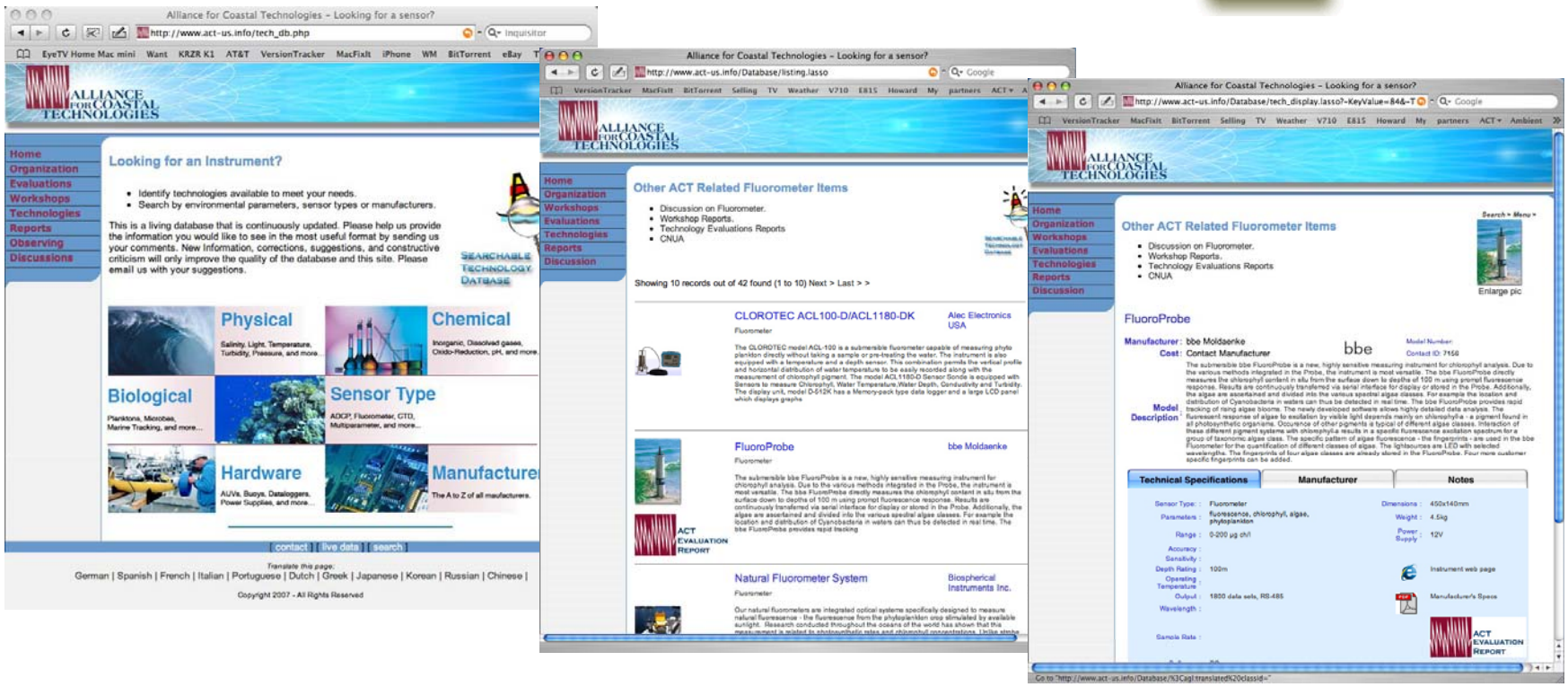
- Emerging Sensors to Identify and Quantify Impacts of Climate Change on Coastal Environments
- In Situ Measurements of pCO_2
- Environmental Sample Concentration Methods/Technologies





Searchable Technology Database

- Organized and standardized relevant information
- Linked to reports and discussions
- Linked to the National Environmental Methods Index

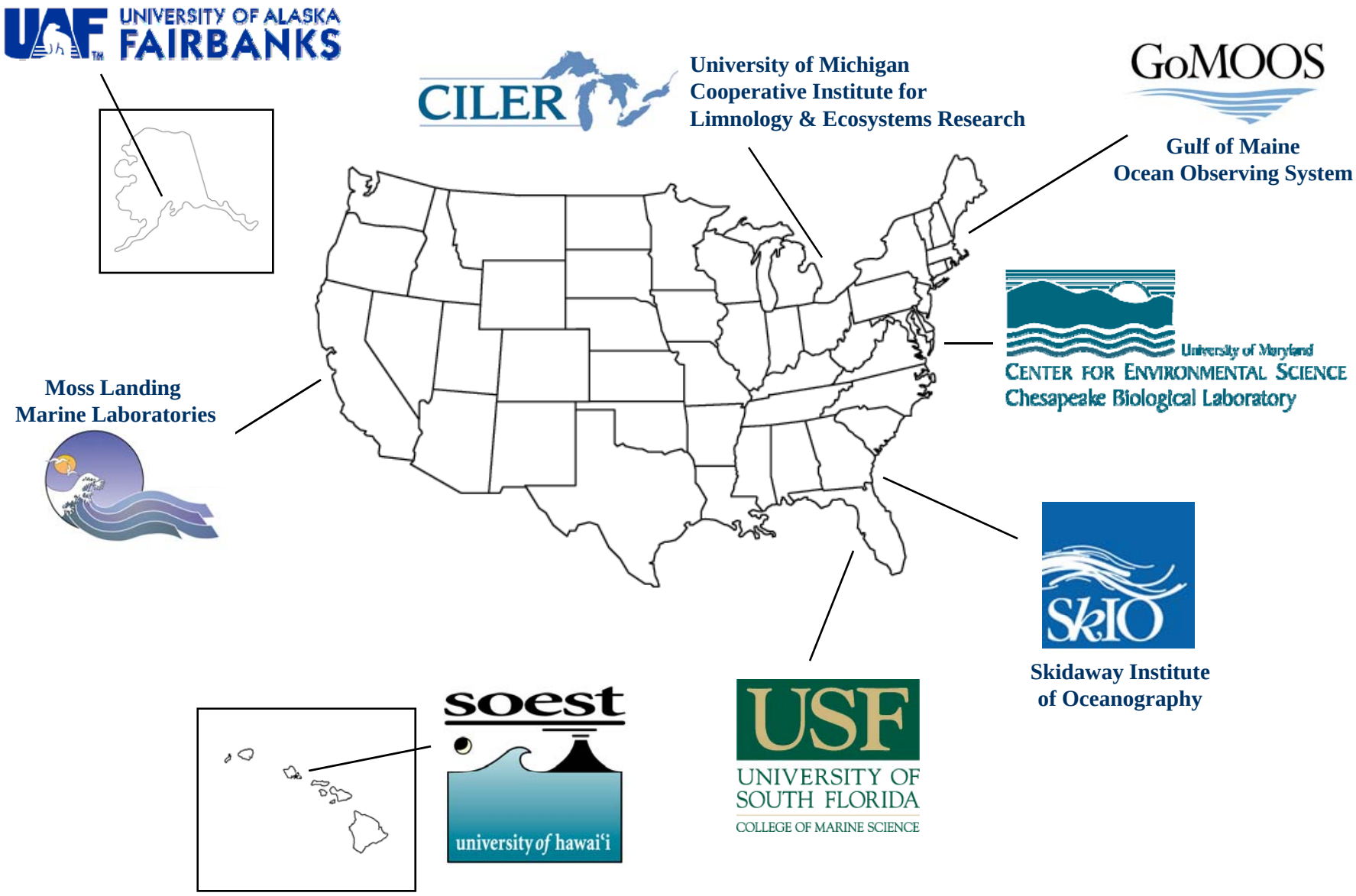


Technology Evaluations

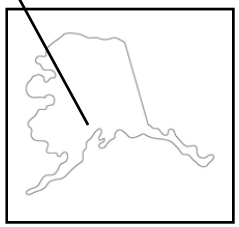
Enable existing and new technologies to be identified and made available for coastal science, management, and IOOS.

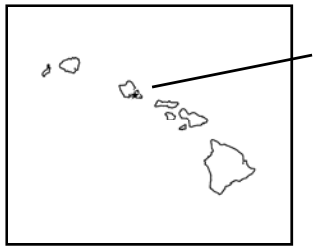
- **Types of Evaluations:**
  - **Performance Verification**
  - **Performance Demonstration**
- **Purpose:**
  - **Document performance under third party tests**
  - **NO certifications, recommendations, or comparisons**
- **Benefits:**
  - **Access to relevant, reliable performance information**
  - **Enhanced ability to identify appropriate technologies**
  - **Level playing field among manufacturers**
  - **Accelerated adoption of innovative technologies**
- **Credibility:**
  - **Objective testing**
  - **Skilled, trained personnel**
  - **Sound methodologies with statistical rigor**
  - **Comprehensive documentation**
  - **Rigorous QA/QC**

Partner Institutions

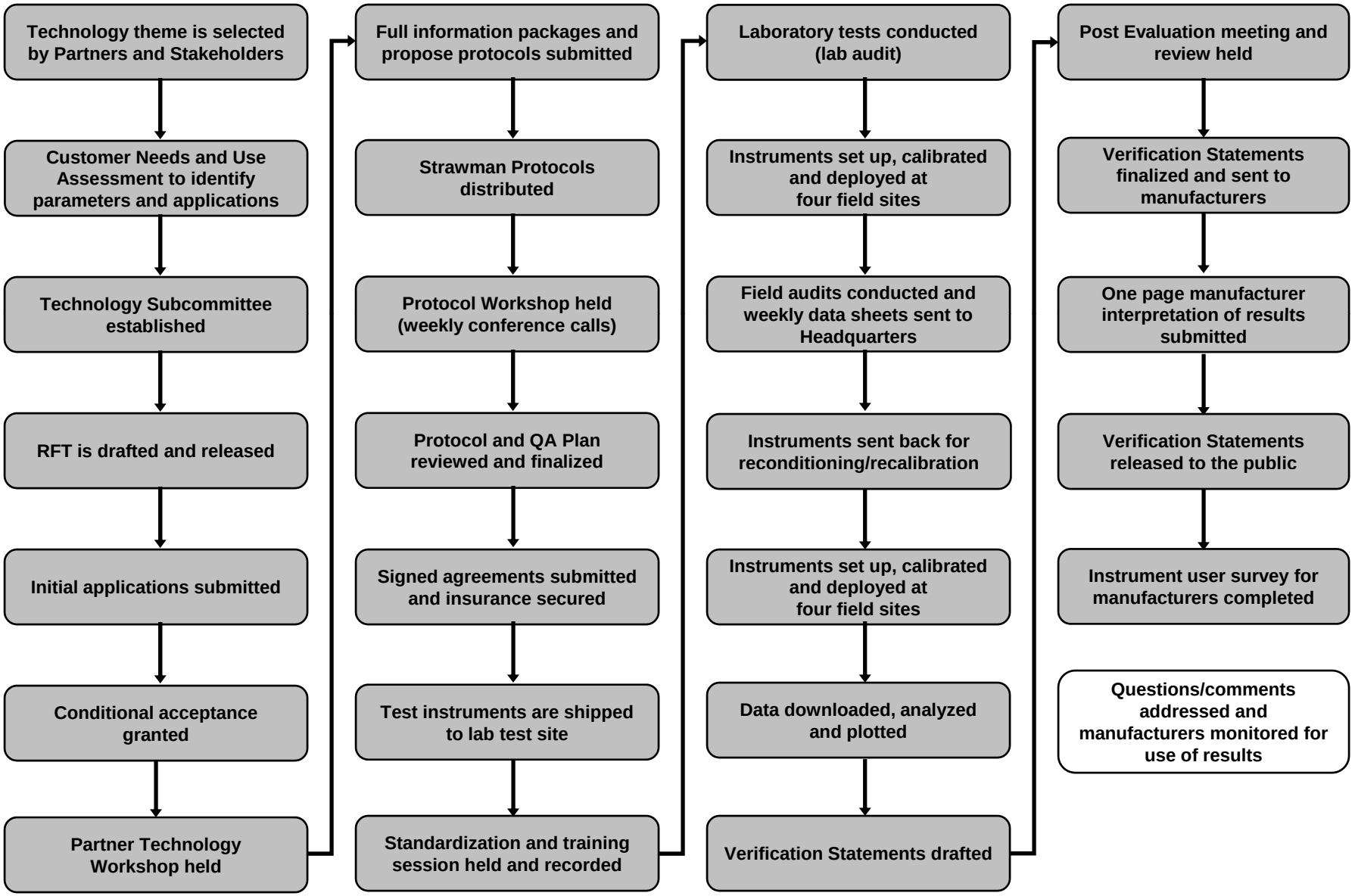


Diverse Environments



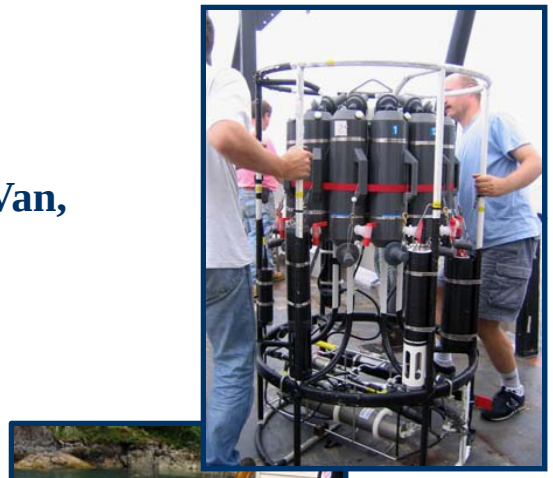


The Process (18 Months)



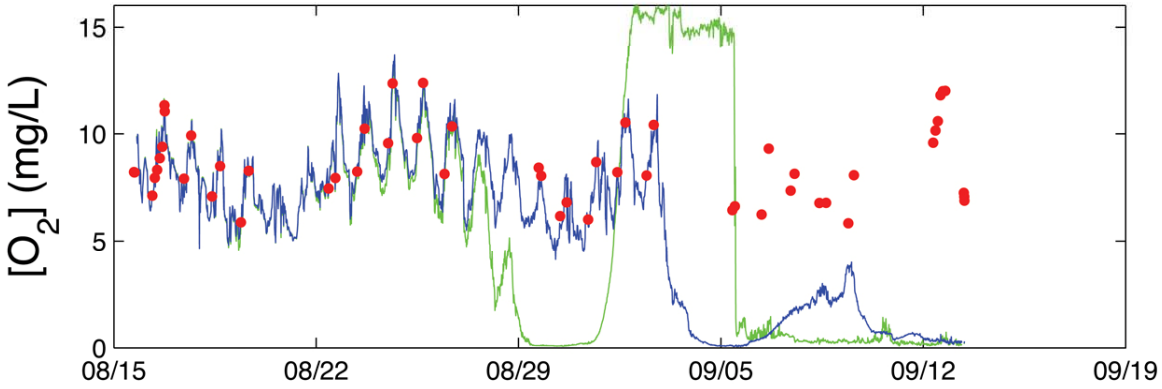
Performance Verifications/Demonstrations

- **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**
- **pCO_2 Sensor (2009/2010)**
- **HAB Sensors (2009/2010)**

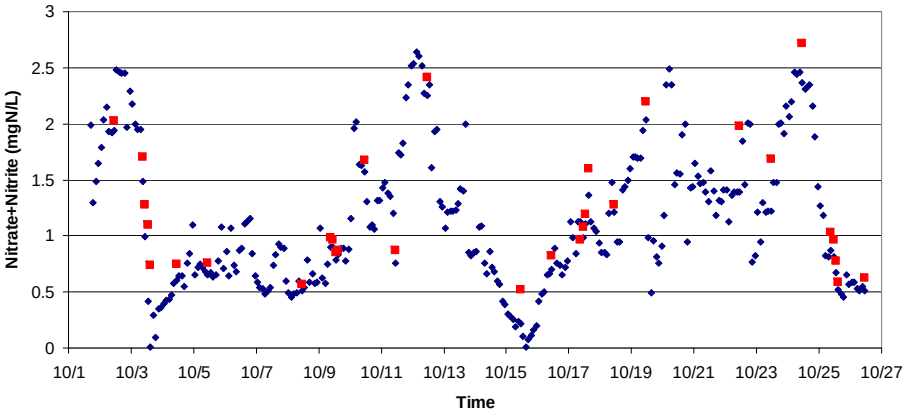


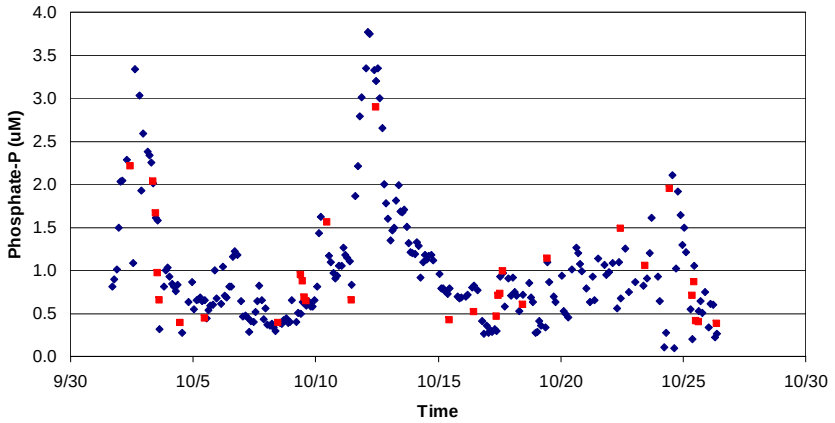
Performance Verifications/Demonstrations

Biofouling



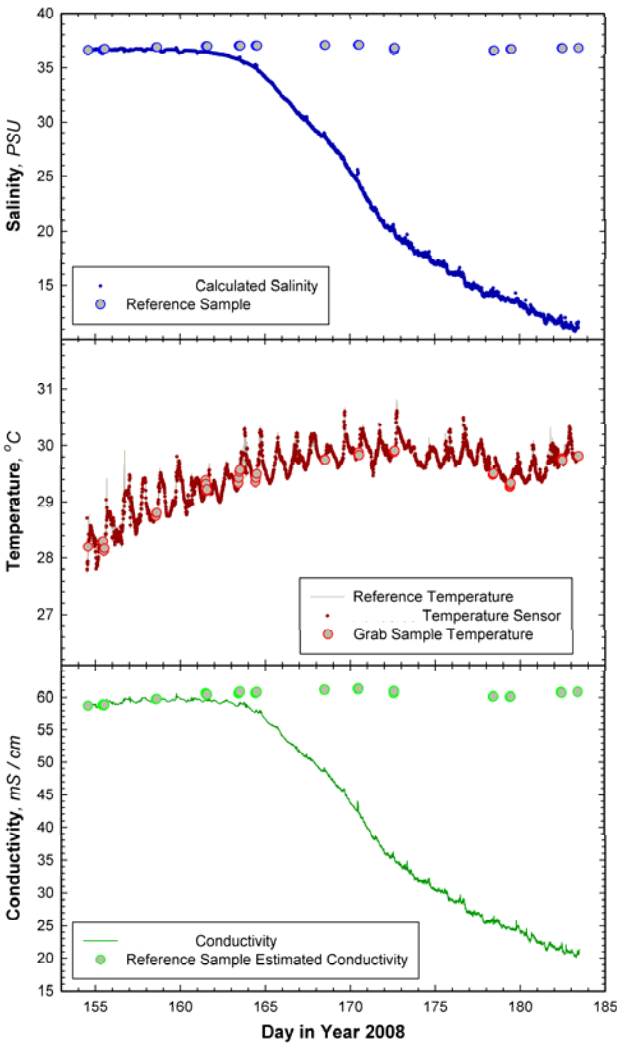
Nutrient Analyzers

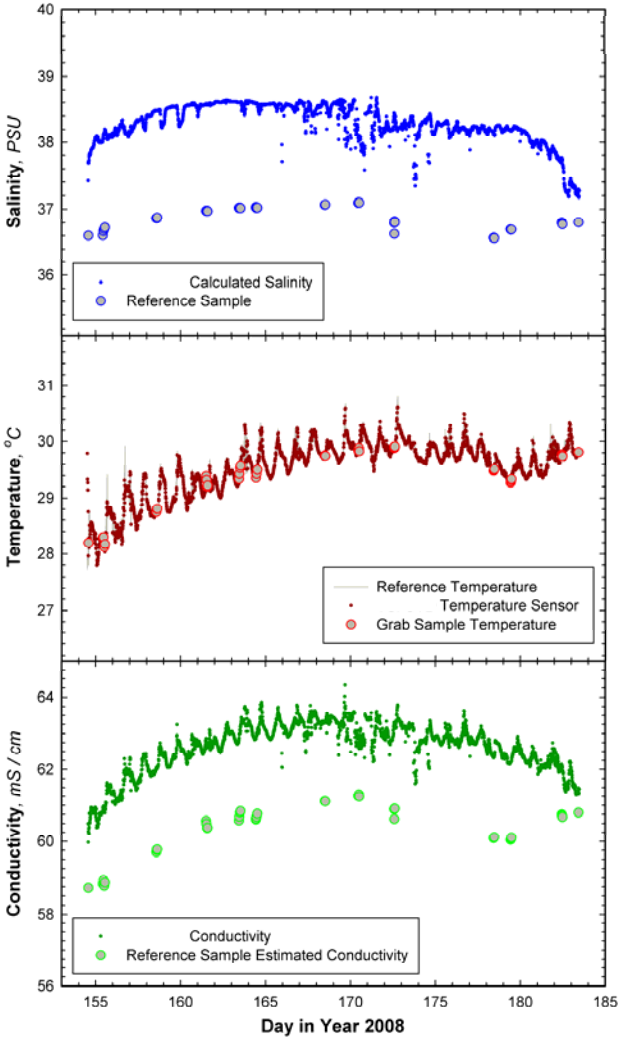




Verifications of Salinity Sensors

- **Examples from offshore of Tampa Bay**





ACT Demonstrations of pCO_2 Analyzers

- Help provide the technologies needed to monitor, understand and predict impacts of anthropogenic CO_2 on coastal ecosystems and ocean acidification.
- Applications from 8 companies and 1 academic researcher
- Instruments being tested:
  - Contros, NOAA/PMEL, Pro-Oceanus, Sunburst, YSI
- Field Tests:
  - Coastal Embayment in Hood Canal, WA
  - Coral Reef in Kaneohe Bay, HI
  - Alaska and Venetian Lagoon (2010)
- Basic Approach:
  - Month-long deployments
  - Daily reference sample collections
  - Pre and post laboratory tests
  - State of the art titration techniques for pH and TA and DIC calculations

Summary

- ACT facilitates the development and adoption of novel instrumentation, while minimizing the risk of artifacts and problems associated with young technology.

- Results from ACT evaluations emphasize that the validation of long-established instruments is critical to assure accurate and reliable ocean observations.

- ACT provides assurance that our basic science understanding, forecasting, and management decisions are based on accurate, precise, and comparable observing data.

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ALLIANCE FOR COASTAL TECHNOLOGIES

Questions – Technology Perspective

- **Where do we need to go?**
  - **Effective monitoring/observing requires high spatial and temporal resolution to address diverse societal needs**
  - **Reliable/robust, accurate/precise instrumentation is key**
  - **Beyond physical and chemical measurements with bio- and geno-sensors**

- **Why aren't we there?**
  - **Market driven technology development**
  - **Standardization and interoperability**

- **How do we get there?**
  - **Significant and sustained local, state and federal commitment to environmental monitoring**