

Climate Change and Variability: Ocean Acidification

Jan Newton, NANOOS

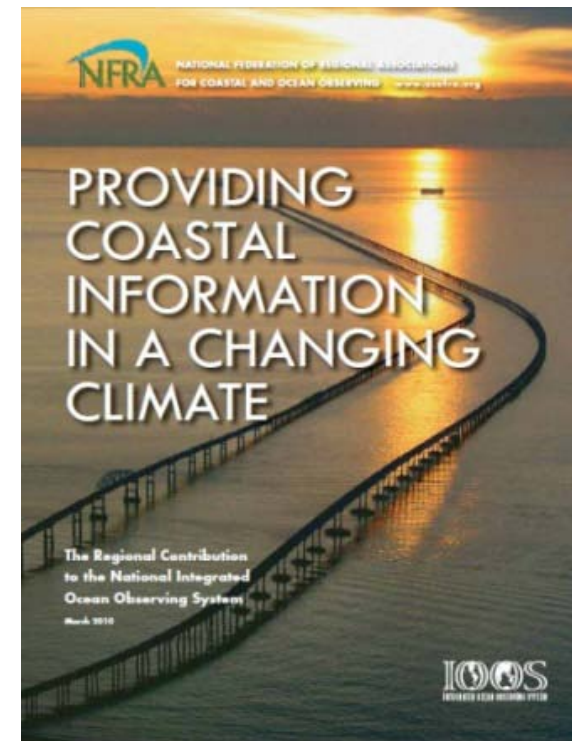
Alex Isern, NSF

Molly McCammon, AOOS

Roy Watlington, CaRA

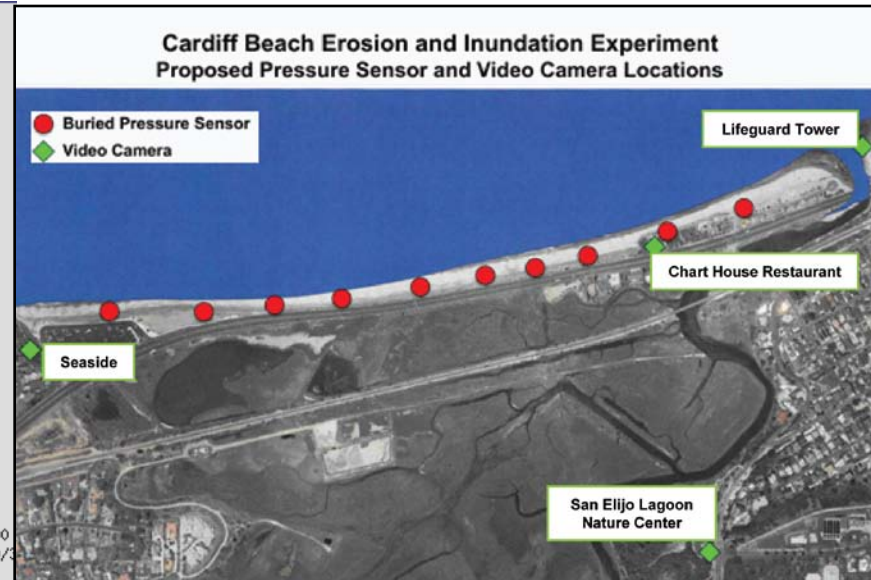
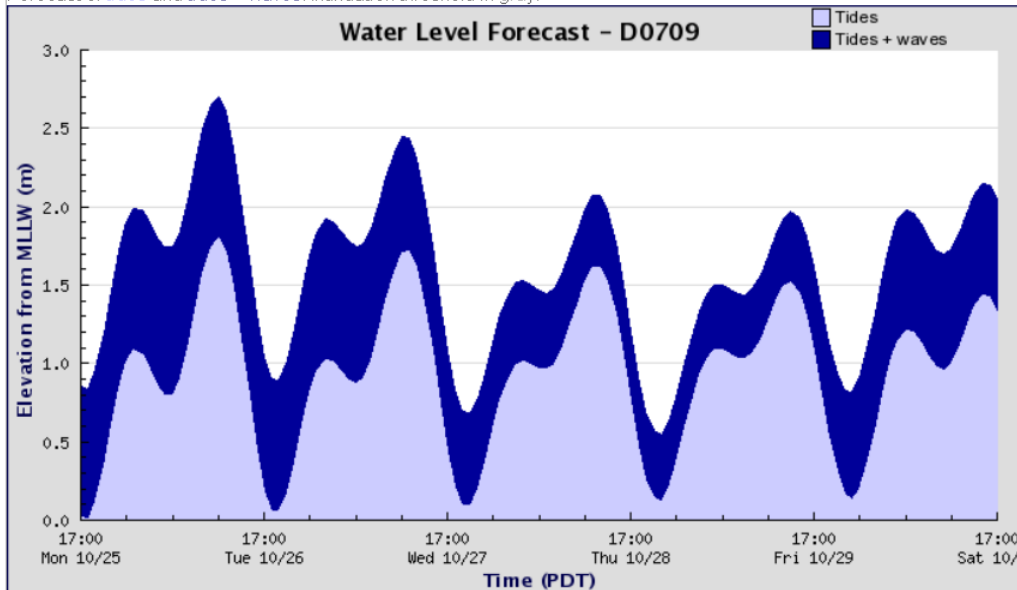
IOOS RA contributions to climate impacts

- Storm surge & inundation
- Sea level rise
- Water properties time series
- Carbon sequestration
- Ocean acidification



Climate Products: Inundation/Sea Level

Most RAs work with users on inundation and SLR



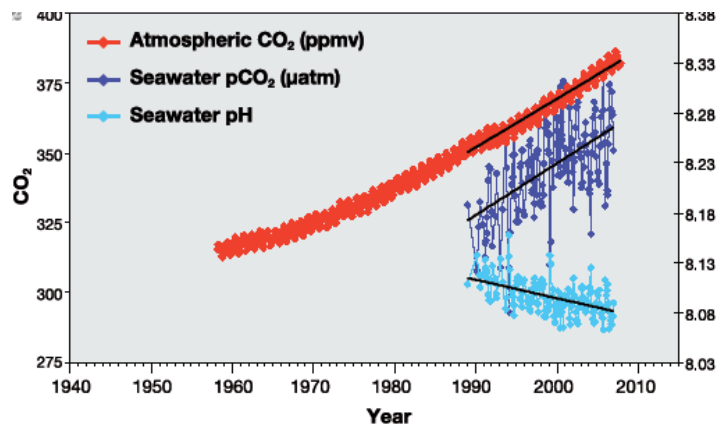
*Automated 3-day
E-mail warnings of
potential inundation
sent to City of Encinitas.*



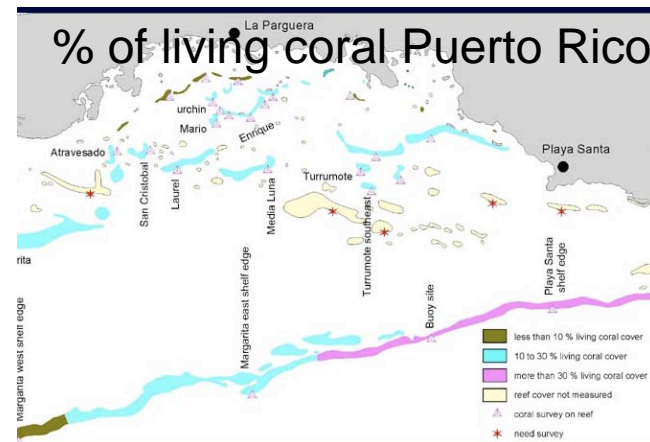
IOOS RA Climate Change Activities



Observations Single system – multiple uses
 NOAA PMEL working with RAs to deploy CO₂ sensors:
 NANOOS; PacIOOS; CaRA, NERACOOS, etc.



Data Management
 RT, trends, public display



Integrated Coral Reef Monitoring



What is Climate Change?

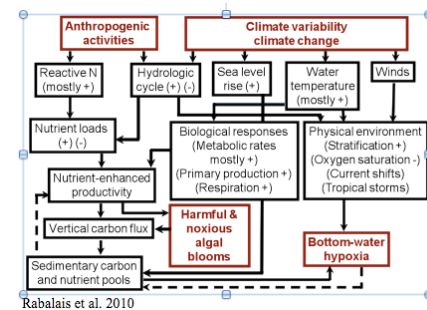
- Long term changes in the weather, over the course of decades, affecting temperature, rainfall, cloudiness, etc.

How does Climate Change affect Pacific Islands?

- Sea level rise.
- Coastal flooding.

Education/Outreach Materials

Modeling

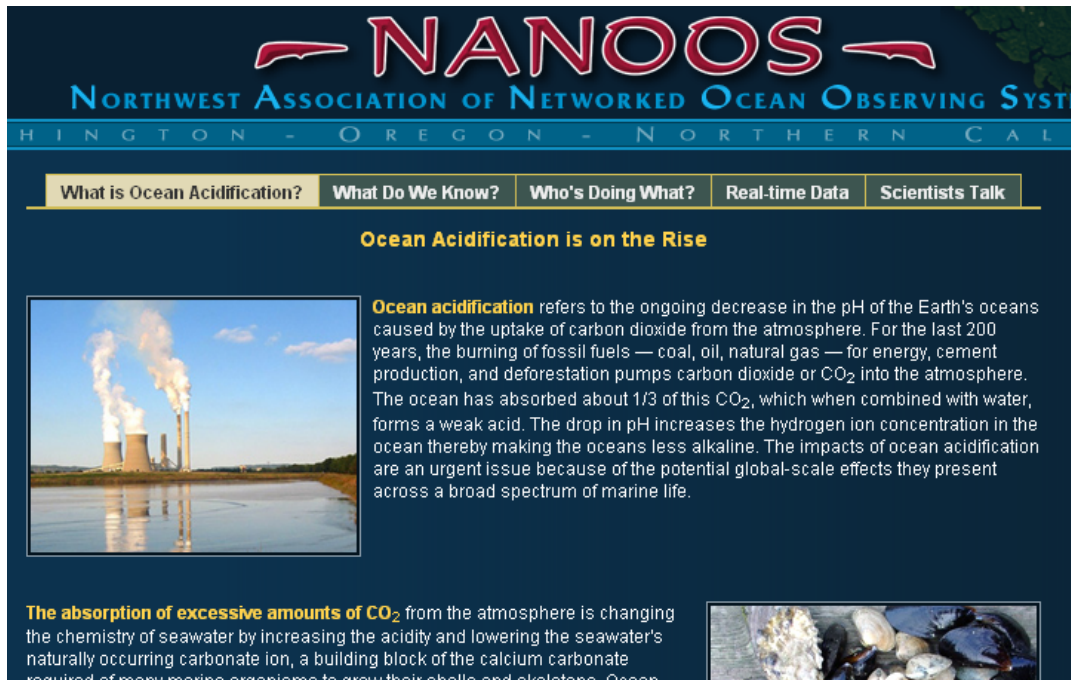


Rabalais et al. 2010



IOOS RAs getting the word, and data, out:

“Theme page” on OA, with real-time data link



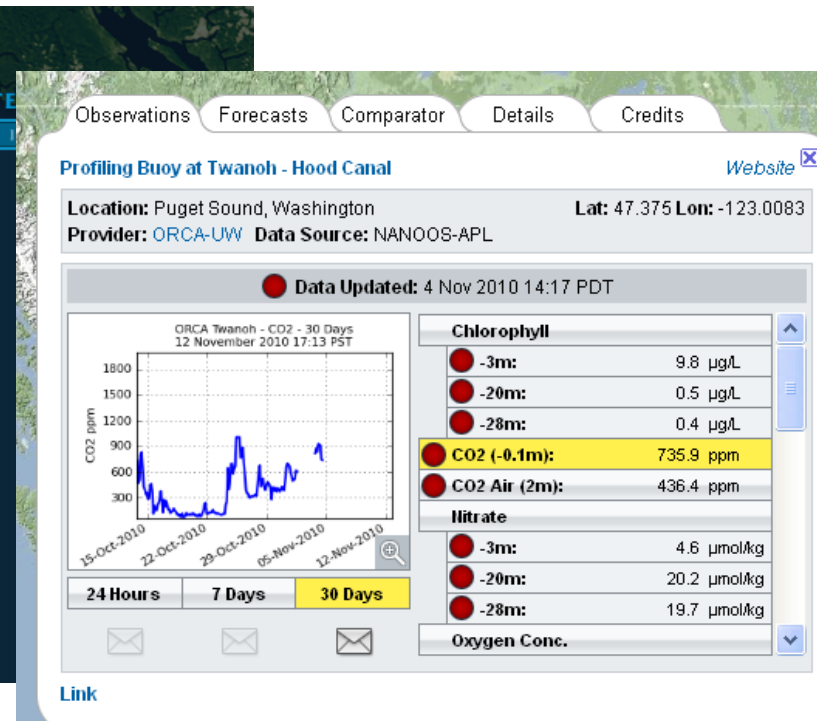
NANOOS
NORTHWEST ASSOCIATION OF NETWORKED OCEAN OBSERVING SYSTEMS
H I N G T O N - O R E G O N - N O R T H E R N C A L I F O R N I A

What is Ocean Acidification? What Do We Know? Who's Doing What? Real-time Data Scientists Talk

Ocean Acidification is on the Rise

Ocean acidification refers to the ongoing decrease in the pH of the Earth's oceans caused by the uptake of carbon dioxide from the atmosphere. For the last 200 years, the burning of fossil fuels — coal, oil, natural gas — for energy, cement production, and deforestation pumps carbon dioxide or CO₂ into the atmosphere. The ocean has absorbed about 1/3 of this CO₂, which when combined with water, forms a weak acid. The drop in pH increases the hydrogen ion concentration in the ocean thereby making the oceans less alkaline. The impacts of ocean acidification are an urgent issue because of the potential global-scale effects they present across a broad spectrum of marine life.

The absorption of excessive amounts of CO₂ from the atmosphere is changing the chemistry of seawater by increasing the acidity and lowering the seawater's naturally occurring carbonate ion, a building block of the calcium carbonate required of many marine organisms to grow their shells and skeletons. Ocean



Observations Forecasts Comparator Details Credits

Profiling Buoy at Twanoh - Hood Canal [Website](#)

Location: Puget Sound, Washington Lat: 47.375 Lon: -123.0083
Provider: ORCA-UW Data Source: NANOOS-APL

Data Updated: 4 Nov 2010 14:17 PDT

ORCA Twanoh - CO₂ - 30 Days
12 November 2010 17:13 PST

Depth	Value
-3m	9.8 µg/L
-20m	0.5 µg/L
-28m	0.4 µg/L
CO ₂ (-0.1m)	735.9 ppm
CO ₂ Air (2m)	436.4 ppm

Depth	Value
-3m	4.6 µmol/kg
-20m	20.2 µmol/kg
-28m	19.7 µmol/kg

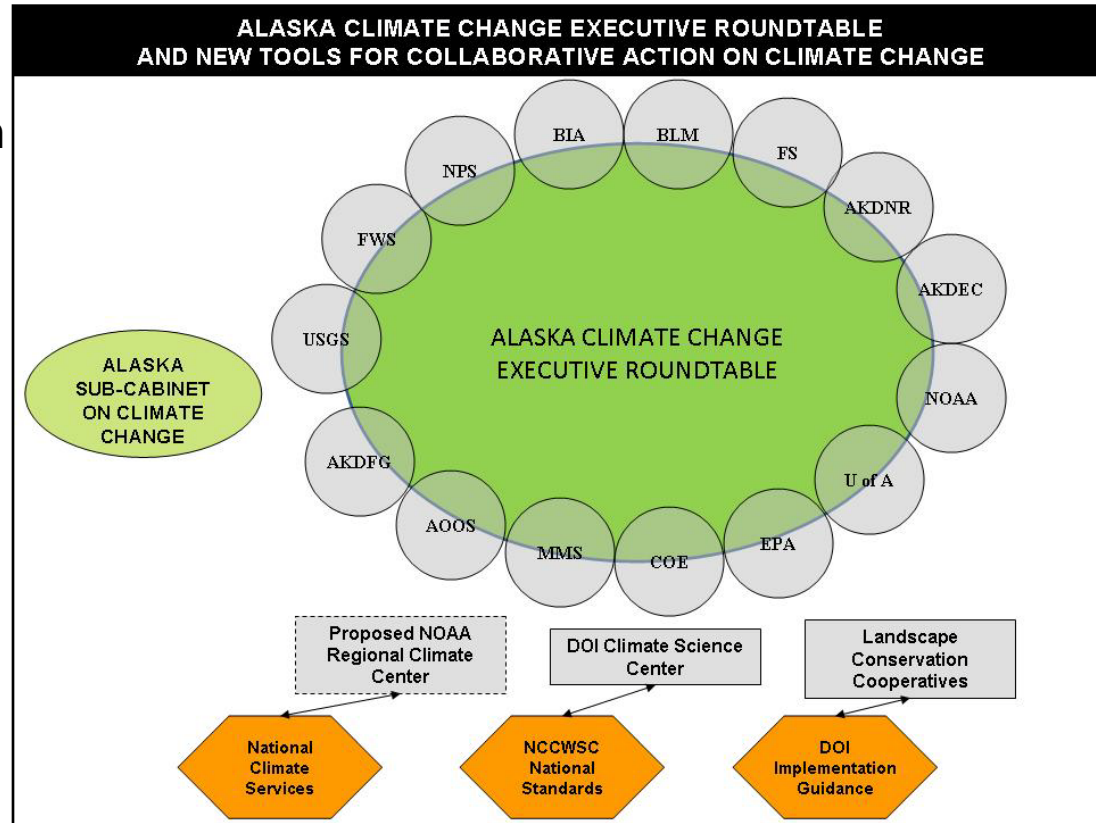
Oxygen Conc.

Link

- NOAA PMEL & NANOOS worked collectively on content
- Sharing with Pacific Science Center, with links to their public displays
- Along with other W Coast RAs, working with shellfish industry

IOOS RA coordination at regional level collaborating with existing programs

- IOOS Regional Associations
- NOAA Natl Climate Service with regional climate director
- NOAA RISA program (Regional Integrated Services)
- NOAA Regional Collaboration Teams
- Dept of Interior regional climate centers & new Landscape Conservation Cooperatives (LCCs)
- Sea Grant Program
- USDA Cooperative Extension Service
- State climatologist
- State coastal management program



This graphic is an example of a coordinated regional approach to responding to climate change.

Evaluations of pCO₂ and pH Sensors:

pCO₂ Sensor Demonstrations during 2010 & 2011

Field tested sensor technologies from Contros, NOAA/PMEL, Pro-Oceanus, Sunburst, and YSI in Hood Canal, WA & Kaneohe Bay, HI

pH Sensor Verification planned for 2012

Climate Change Symposium and Workshop: **Alaska, May 2011**

Discussion of technologies to quantify changes to:

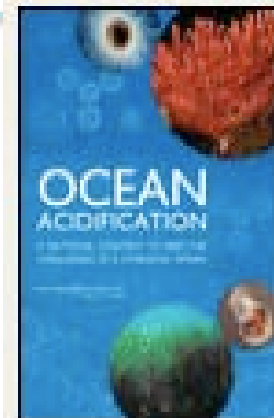
- Weather patterns and storm severity
- Biogeochemical cycles and ecosystem processes
- Ocean temperature and acidification
- Sea level rise and coastal erosion
- Sea ice retreat



AOOS
Alaska Ocean Observing System

Elements of a National OA Observing Network

- Calls for the creation of a National Ocean Acidification Program
- Monitoring program should include: temperature, salinity, oxygen, nutrients, and carbon parameters (DIC, $p\text{CO}_2$, total alkalinity, pH).
- Measurements of general indicators of ecosystem change should be supported as part of a program for assessing the effects of acidification.
- NOAA Program should review existing and emergent observing networks to identify measurements that could become part of a comprehensive ocean acidification observing network and to identify any critical spatial or temporal gaps in the current capacity to monitor ocean acidification.



Management and Decision Support

The National Ocean Acidification Program should

- plan for the long-term sustainability of an integrated ocean acidification observation network.
- identify, engage, and respond to stakeholders in its assessment and decision support process and work with existing climate service and marine ecosystem management programs to develop a broad strategy for decision support.

Data Management

- create and fund a data management office and identify appropriate data center(s) for archiving data or create its own.
- support inter-calibration, standards development, and efforts to make methods of acquiring chemical and biological data clear and consistent.
- support the development of satellite, ship-based, and autonomous sensors as part of a network

Discussion Questions

- What unique opportunities do the RAs offer for system-wide monitoring of the coastal effects of OA ?
- How can the IOOS system help address the needs of a OA observing system ?
- Within each region, are the highest state and regional needs being addressed by current direction of the OA monitoring ?
- What role can the RAs play in addressing other coastal climate monitoring needs ?