



National Ocean Acidification Observing Network

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Ocean in High CO₂ World Symposium
September 26, 2012

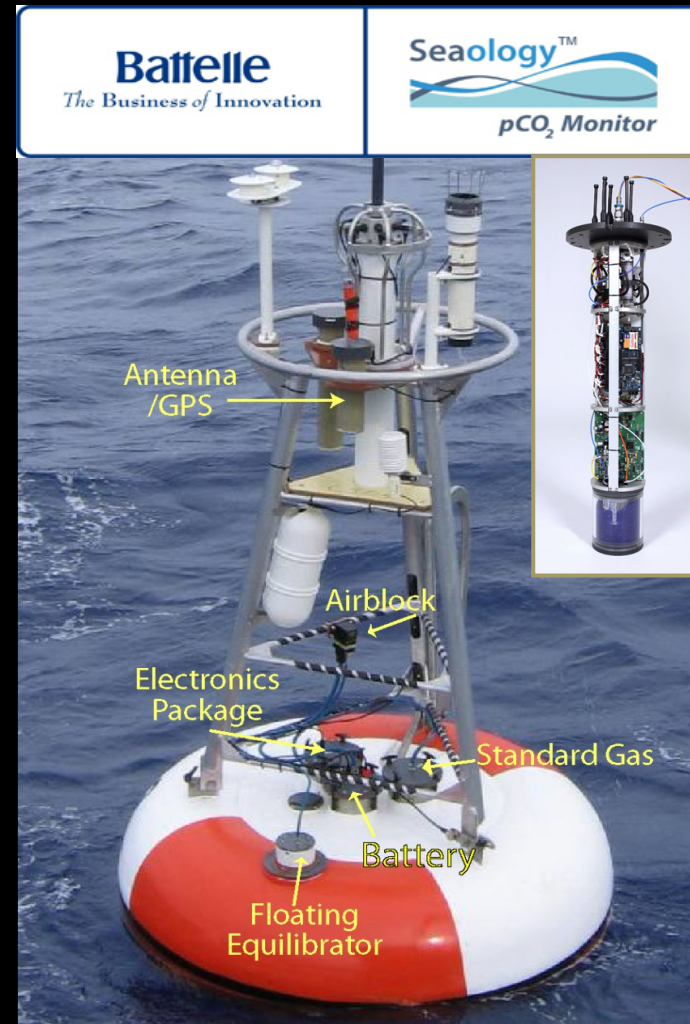
Vision

“This network will provide a better understanding of the temporal and spatial scales of variability in ocean carbon chemistry and biology and the observational basis for developing predictive models for future changes in ocean acidification and its consequences for marine ecosystems.”

- NOAA Ocean and Great Lakes Acidification Research Plan, 2010

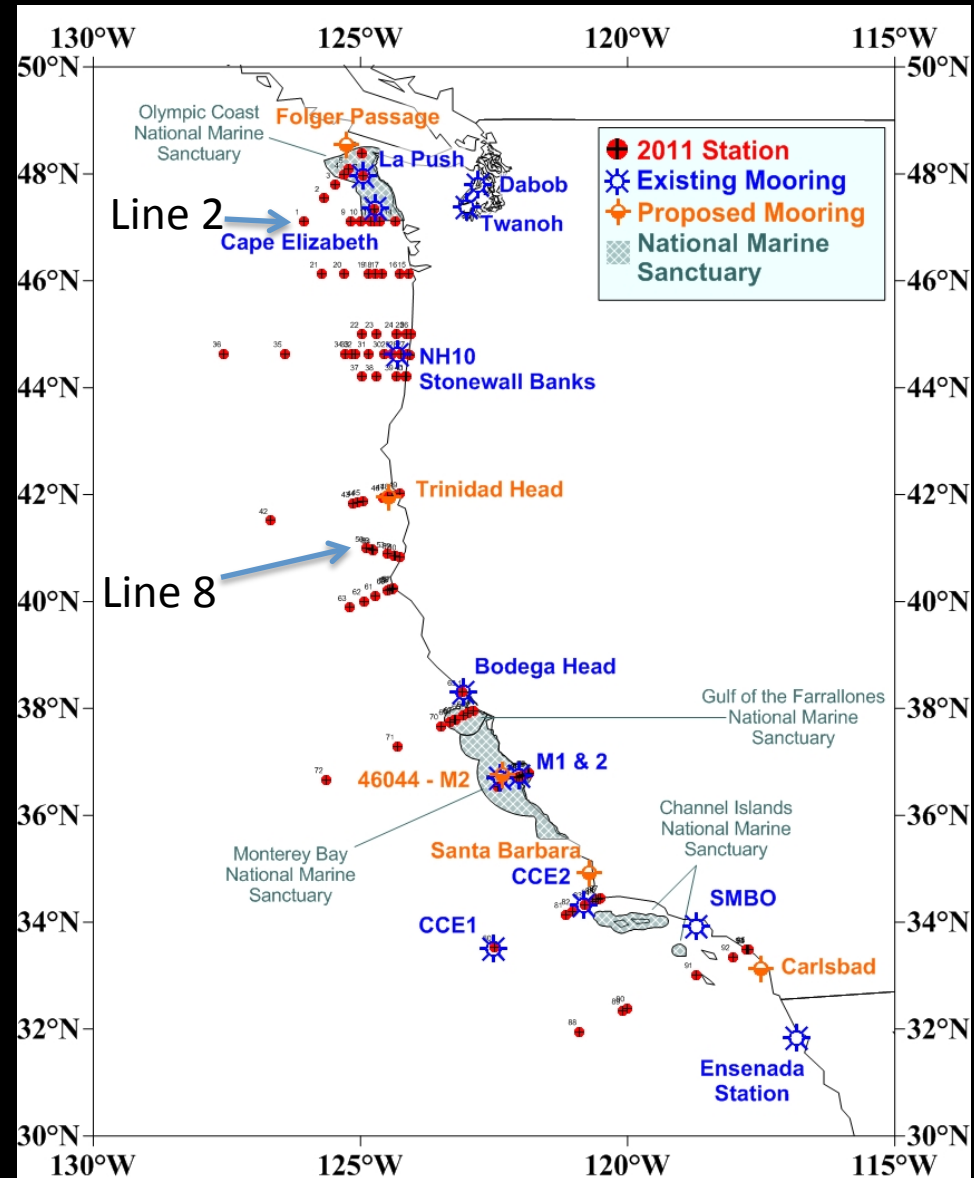
Ocean Acidification Observing

- Fixed site observing platforms
- Ships of opportunity
- Repeat hydrography and dedicated OA cruises
- Biogeochemical Modeling
- New technologies

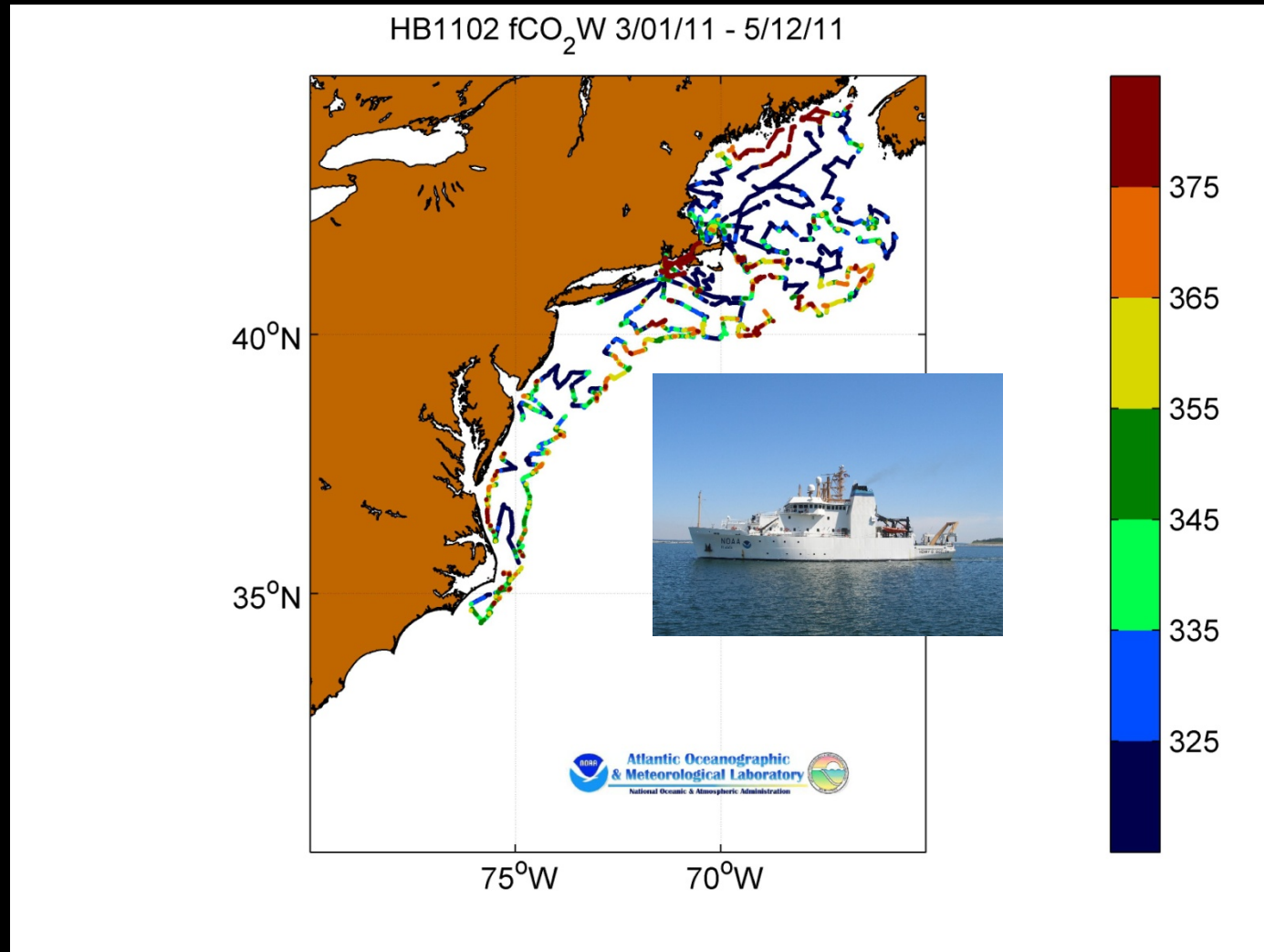


Coastal OA Survey Cruises

The West (and East/Gulf) Coast OA Cruises are designed to delineate the extent and magnitude of the exposure of US coast ecosystems to “acidified” conditions.



Ships of Opportunity



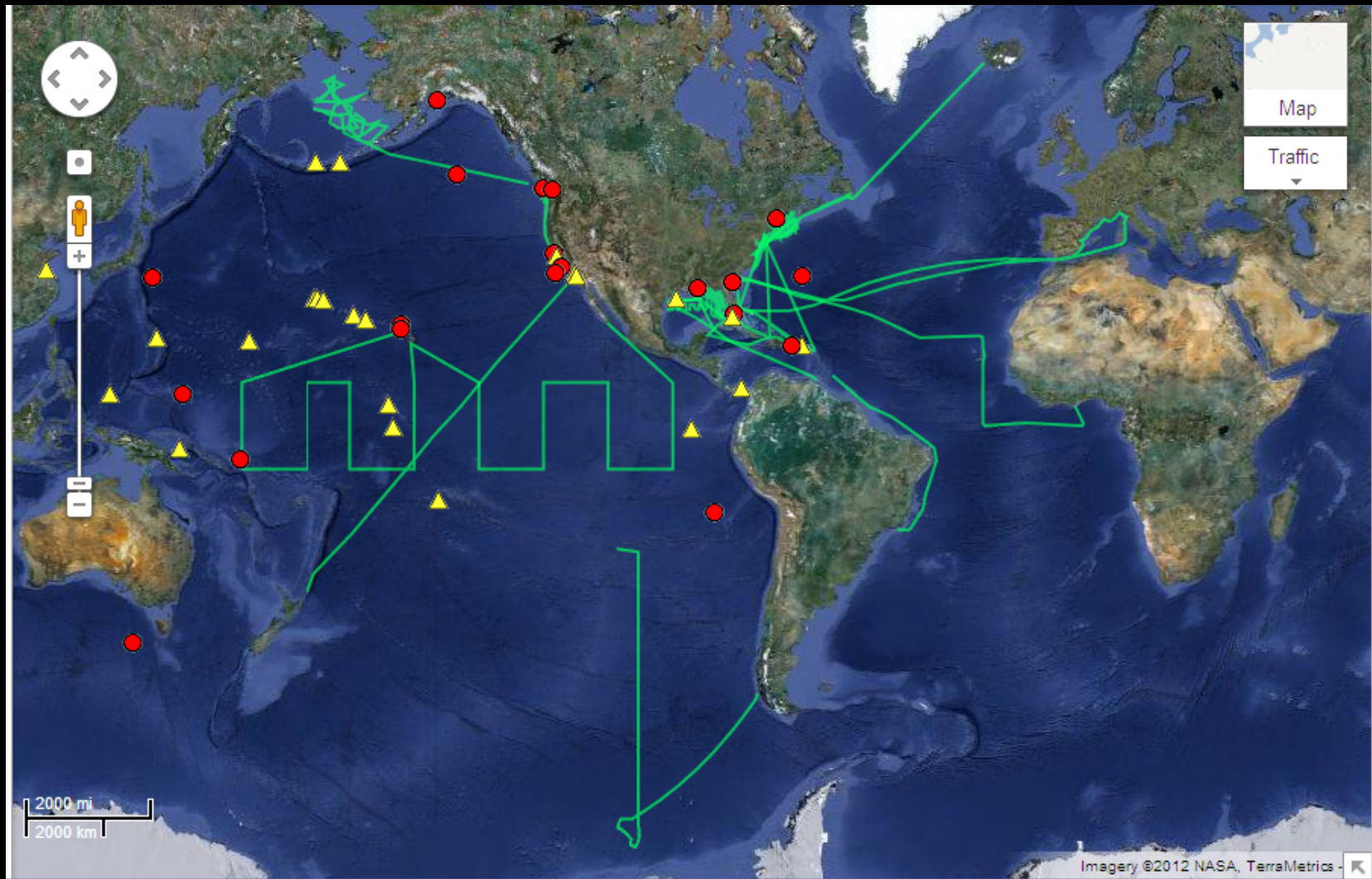
AOML and NMFS: First surface water CO₂ data from NOAA ship *Henry B. Bigelow*

New Technologies

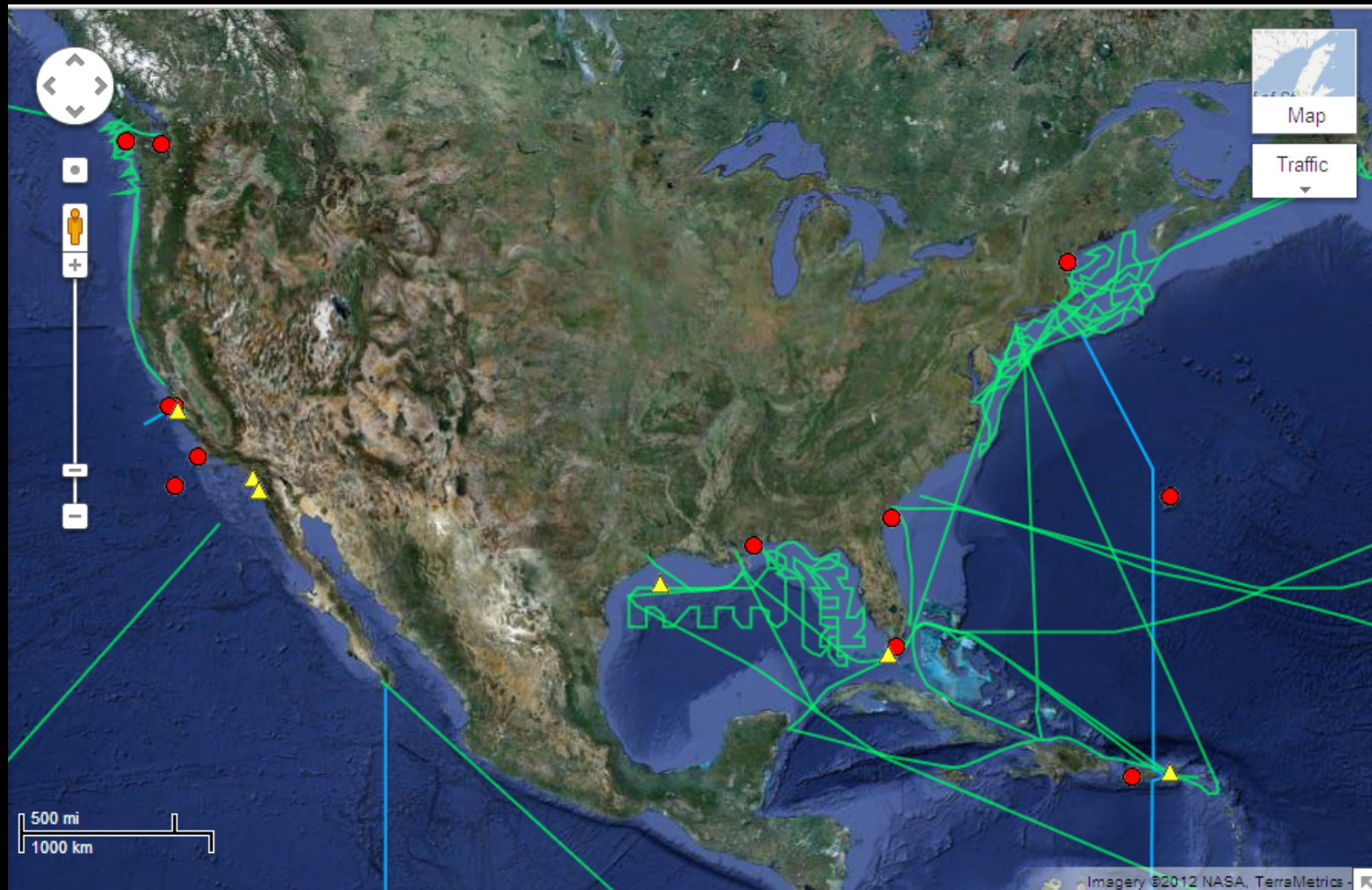
Carbon Wave Glider



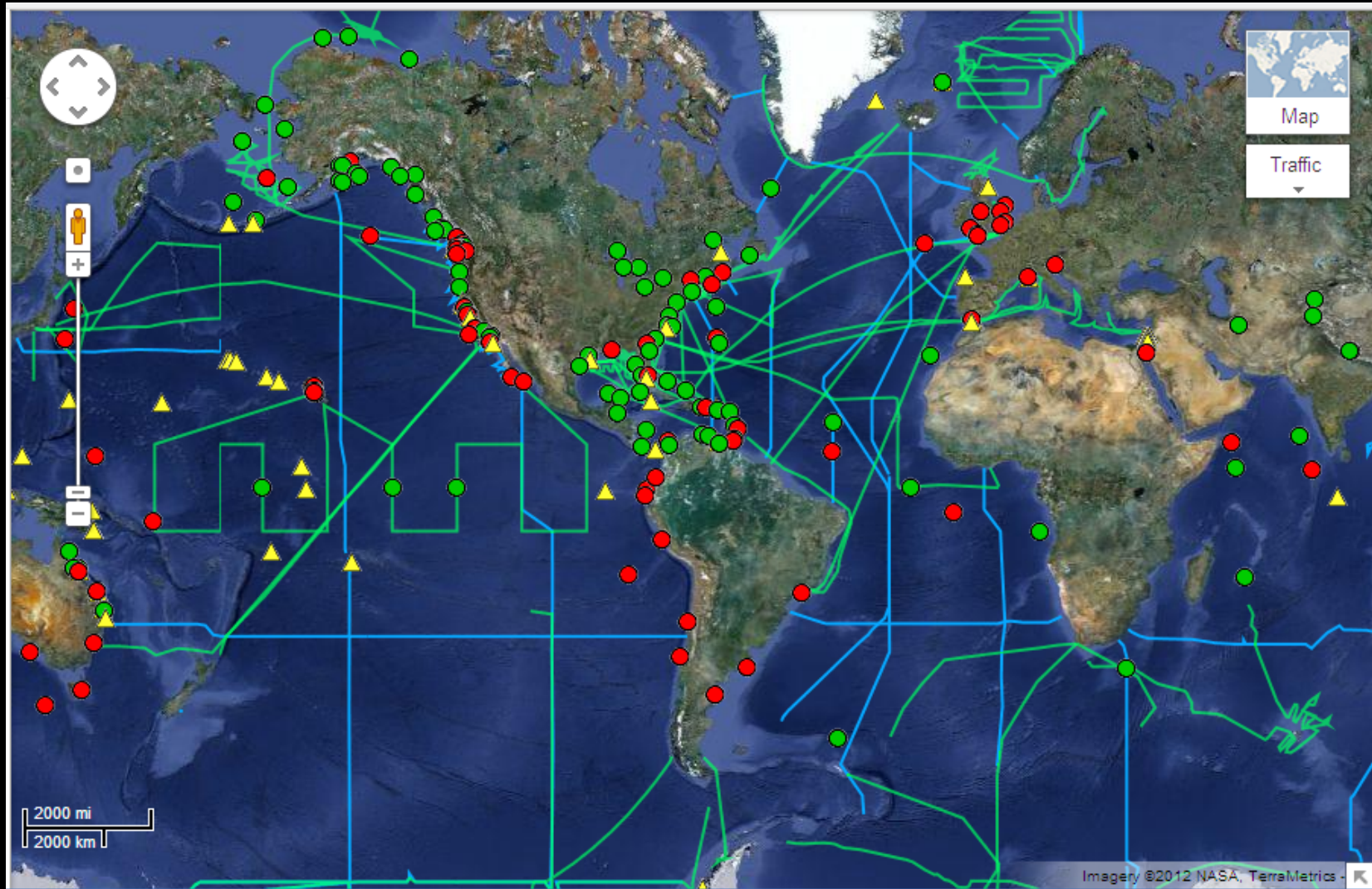
US-funded Observing Network



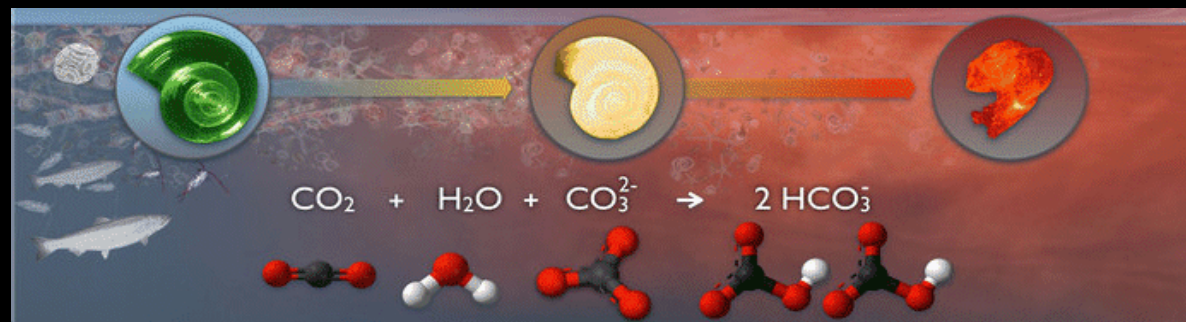
Lower 48 Network



International Observing Network

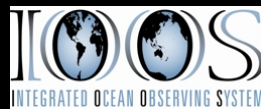
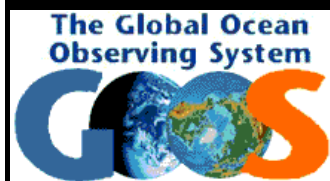
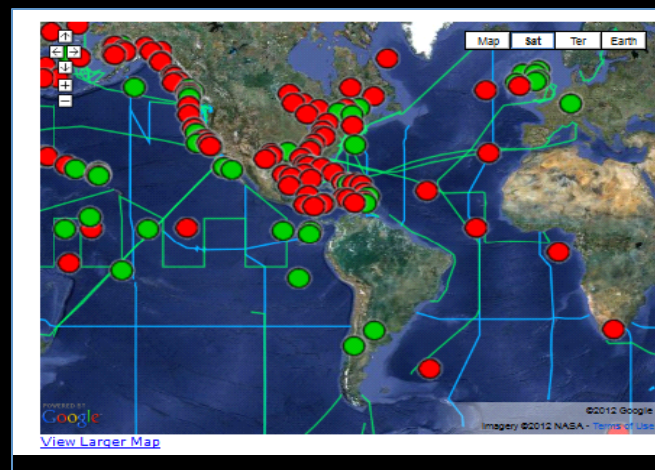


<http://www.pmel.noaa.gov/co2/story/International+Workshop+-+Ocean+Acidification>



Toward a Global Ocean Acidification and Ecosystem Response Observing Network

An international workshop held at the
University of Washington
Seattle, WA, USA
26-28 June 2012



International Observing Workshop

Goals

1. Provide the **rationale and design** of the components and locations of an international carbon and ocean acidification observing network that includes repeat hydrographic surveys, underway measurements on volunteer observing ships, moorings, floats and gliders taking into account existing networks and programs wherever possible;
2. Identify a **minimum suite** of measurement parameters and performance metrics for each major component of the observing system; and
3. Develop a **strategy** for data quality assurance and data distribution; and
4. Discuss **requirements** for program integration at the international level.

Workshop Participants

- 62 scientists from 23 countries
 - Carbon chemists, oceanographers, biologists, a few data managers, modelers
 - USA, Australia, Sweden, Venezuela, Bermuda, Taiwan, China, Canada, New Zealand, UK, Mexico, Norway, Chile, Korea, China, South Africa, Japan, Iceland, India, Israel, Italy, Germany, France
- These participants and more identified existing (green) and planned (red) OA observing assets



The diagram illustrates the chemical process of ocean acidification. It shows a sequence of three circular icons: a green sphere (representing CO₂), a yellow sphere (representing H₂O), and a red sphere (representing CO₃²⁻). Arrows indicate the flow from left to right. Below the icons, the chemical equation is shown: $\text{CO}_2 + \text{H}_2\text{O} + \text{CO}_3^{2-} \rightarrow 2 \text{HCO}_3^-$. Below the equation, molecular models of the reactants and products are shown.

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▶ [Global Ocean Observing System](#)
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Workshop Goals
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International Workshop to Develop an Ocean Acidification Observing Network of Ship Surveys, Moorings, Floats and Gliders
University of Washington, Seattle
June 26 - June 28, 2012

Introduction and Background
In order to coordinate international efforts to document the status and progress of ocean acidification in open-ocean and coastal environments, and to understand its drivers and impacts on marine ecosystems, it will be necessary to develop a coordinated multidisciplinary multinational approach for observations and modeling that will be fundamental to establishing a successful research strategy for ocean acidification. This will facilitate the development of our capability to predict present-day and future responses of marine biota, ecosystem processes, biogeochemistry, and climate change feedbacks. Required research elements include regional and global networks of observations collected in concert with process studies, manipulative experiments, field studies, and modeling. Global and regional observation networks will provide the necessary data required to firmly establish impacts attributable to ocean acidification. With support from the NOAA Ocean Acidification Program, the International Ocean Carbon Coordination Project, the Global Ocean Observing System, the Integrated Ocean Observing System, and the University of Washington, this international workshop will propose an integrated global observing network for both carbon and ocean acidification that addresses the requirements of nations affected by this emerging environmental problem in response to societal needs.



The map shows the global distribution of ocean acidification observing assets. Red dots represent planned assets, and green dots represent existing assets. The map is overlaid with a grid of latitude and longitude lines. The assets are concentrated in the North Atlantic, the North Pacific, and the Indian Ocean. The map is titled "Map Sat Ter Earth" and includes a "View Larger Map" link.

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Imagery ©2012 NASA
[View Larger Map](#)

WHAT the network needs to provide

Goal 1. An understanding of global OA conditions:

Identify spatial/temporal patterns and assess generality of response; document and assess variation to infer mechanisms driving condition; quantify rate of change and ID areas of vulnerability

Goal 2. An understanding of ecosystem response to OA:

Measure biological responses to physical/chemical changes; quantify rate of change and ID areas of vulnerability

Goal 3. Input data to optimize modeling for OA:

Provide spatially and temporally resolved data for model initial conditions and evaluation; then use model output to aid #1-2

Goal 1 Level 1 Measurements

- T, S, O, Carbonate-system Constraint
- Fluorescence* and Irradiance*

**Except where platform is not appropriate or available for this measurement*

Carbonate-system constraint can be achieved in a number of ways, including combinations of measurements and synthetic, non-collocated estimates of other parameters.

Goal 2 Level 1 Measurements

Ocean: (in addition to phys/chem)

Biomass of functional groups:

- Phytoplankton: timing of bloom, community shifts
- Zooplankton
 - micro (e.g., protists)
 - meso (meroplankton, multicellular)
- Microbes

Coast: (in addition to Ocean)

- Benthic animals, algae, and plants

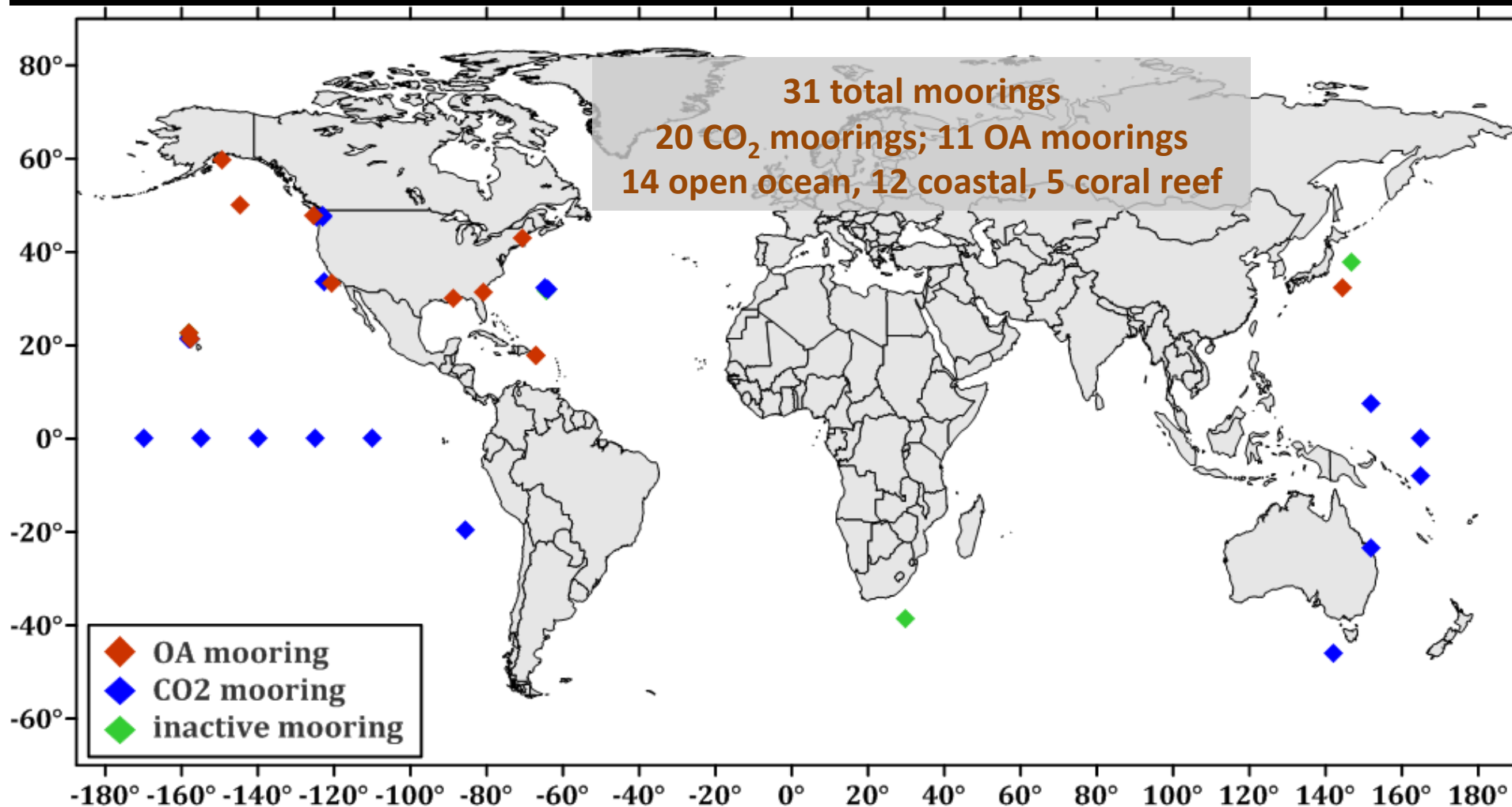
Goal 2 Level 1 Measurements

Coral Reef:

- Processes:
Calcification/Dissolution (Net Ecosystem Calcification)
Production/Respiration (Net Primary Prod'n)
- Sensors/Measurements:
DIC, TA, O₂, T, S, Light, current
- Biomass/abundance of functional groups:
Corals, macroalgae/turf algae, coralline algae
(to assess shifts)

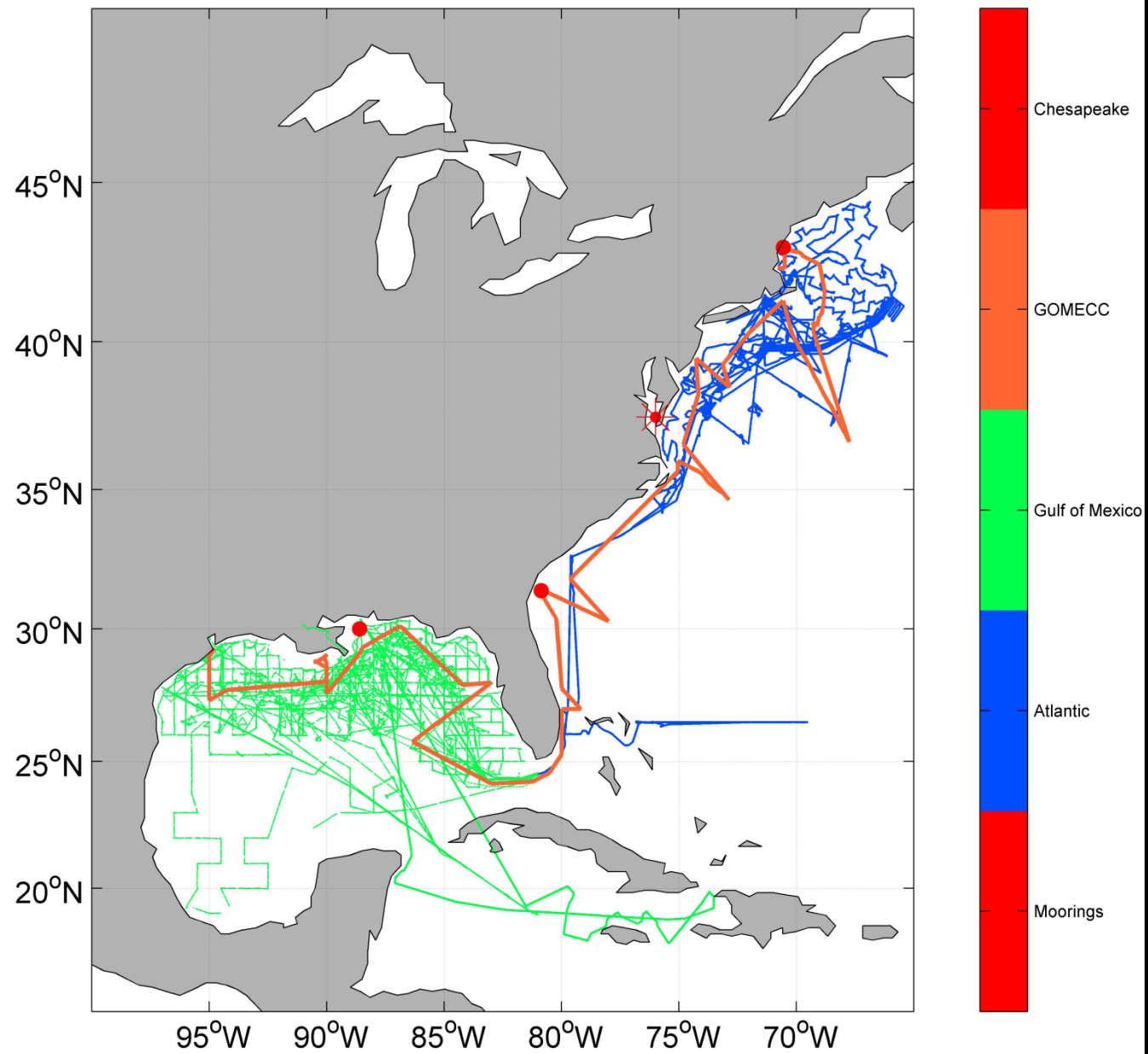
Questions?

NOAA PMEL Mooring Network

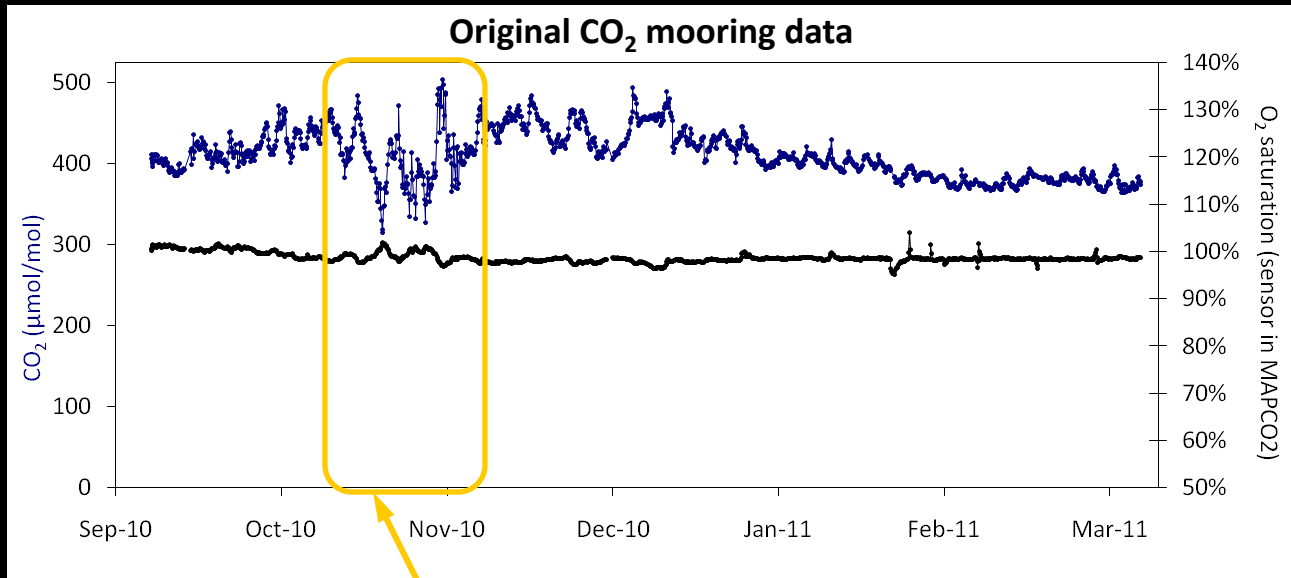


Supported by NOAA's Office of Climate Observation (OCO), NOAA's Ocean Acidification Program, and a variety of partners

Ocean Acidification Monitoring

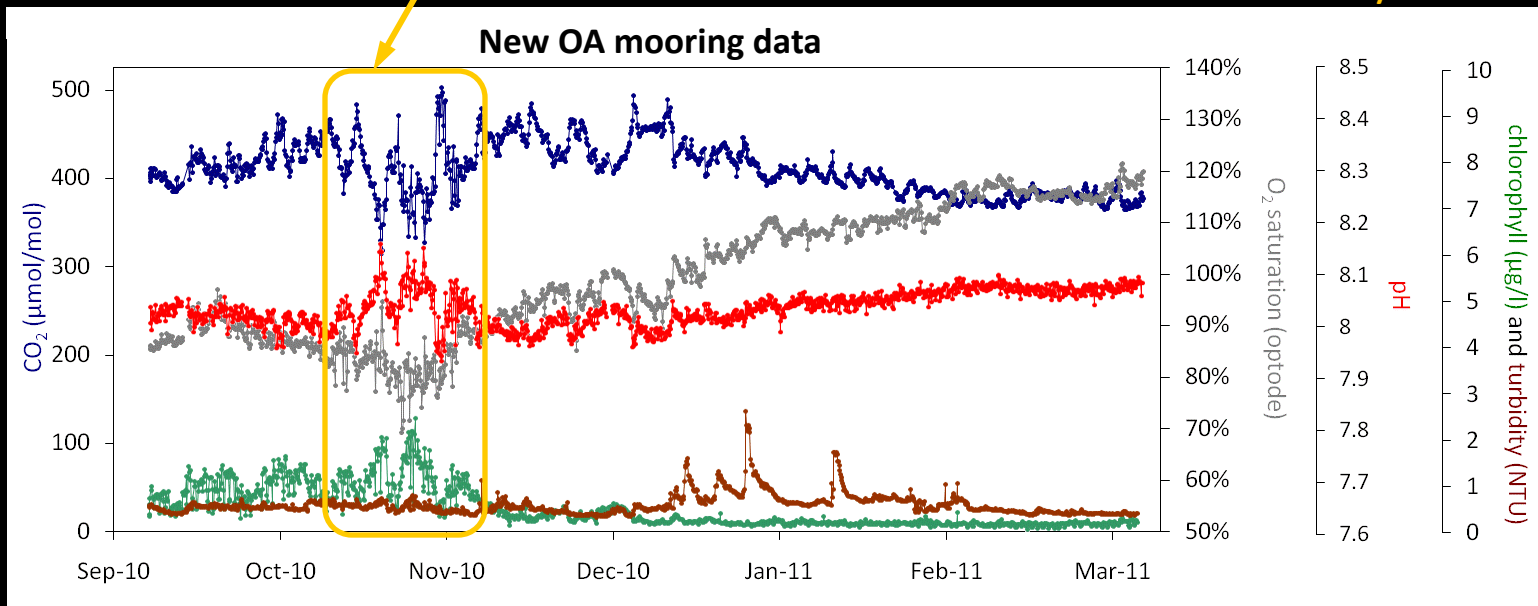


Gulf of Maine OA Mooring



CO₂ mooring data:
CO₂
O₂ in equilibrated air

New sensors provide insights into the influence of biology on short-term variations in ocean carbon chemistry



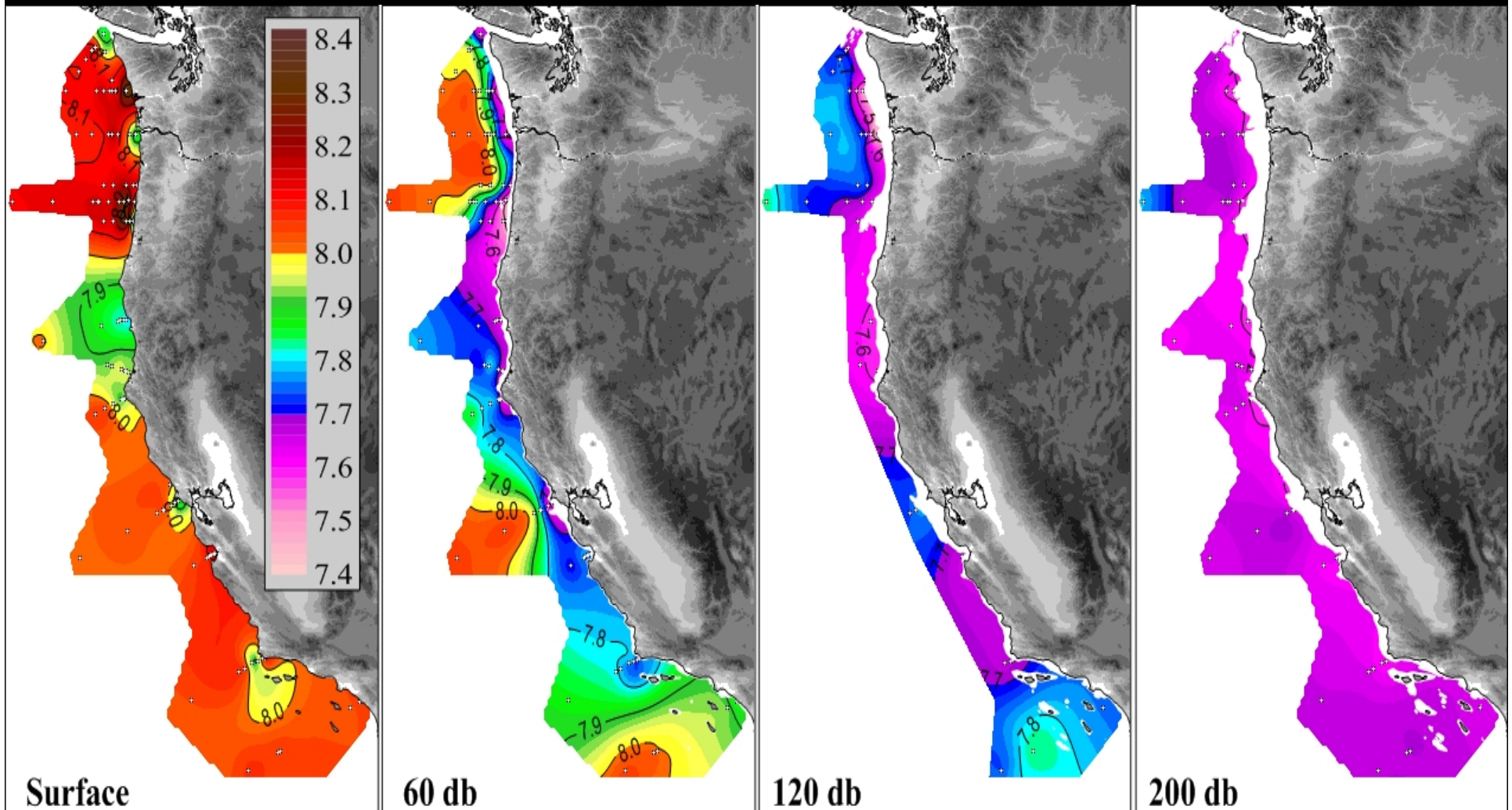
OA mooring data:
CO₂
pH
SSTC
optode O₂
fluorescence
turbidity



NOAA West Coast Ocean Acidification Program

Continental shelf carbon budgets, dynamics, and processes

2011 August – September pH distribution

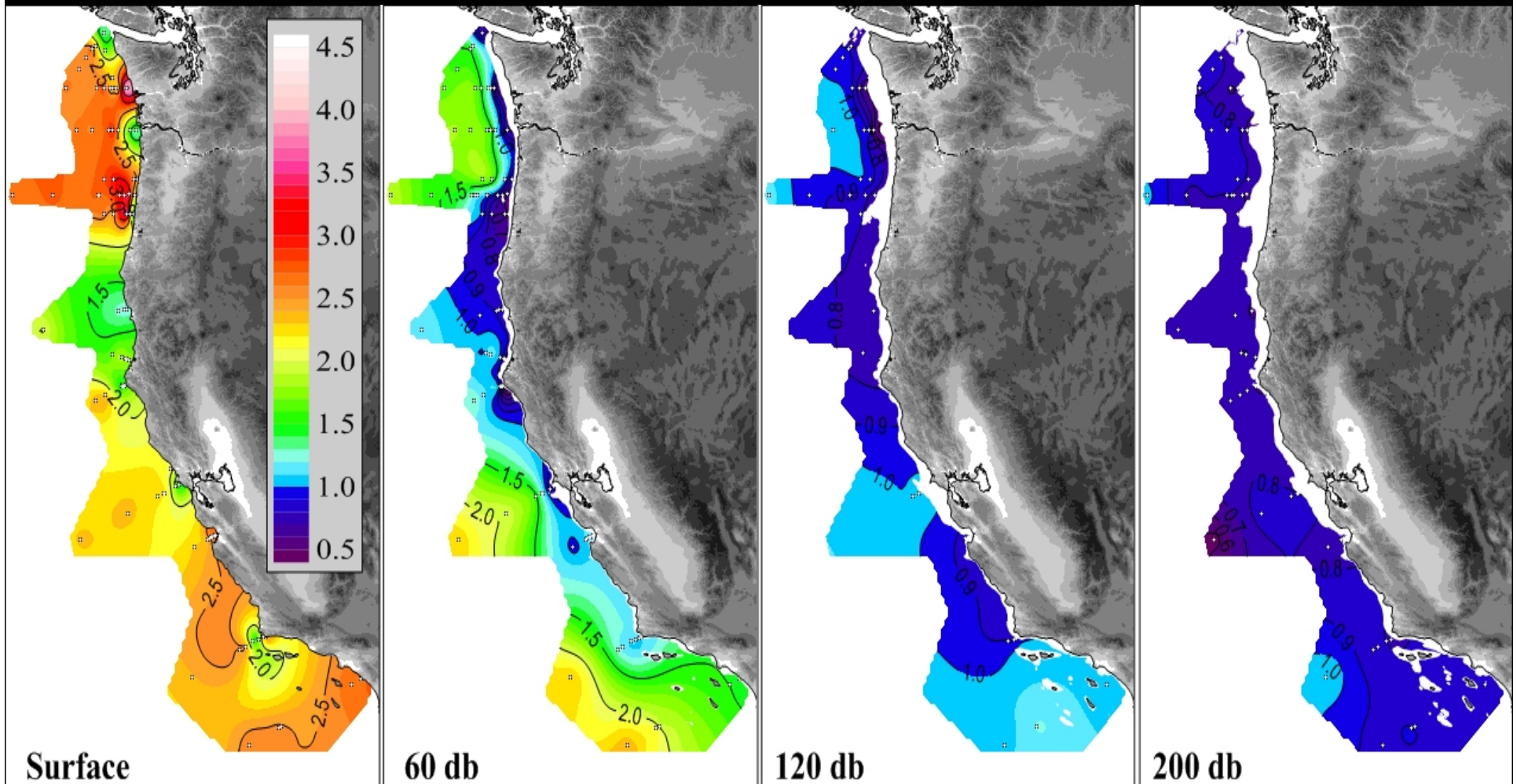


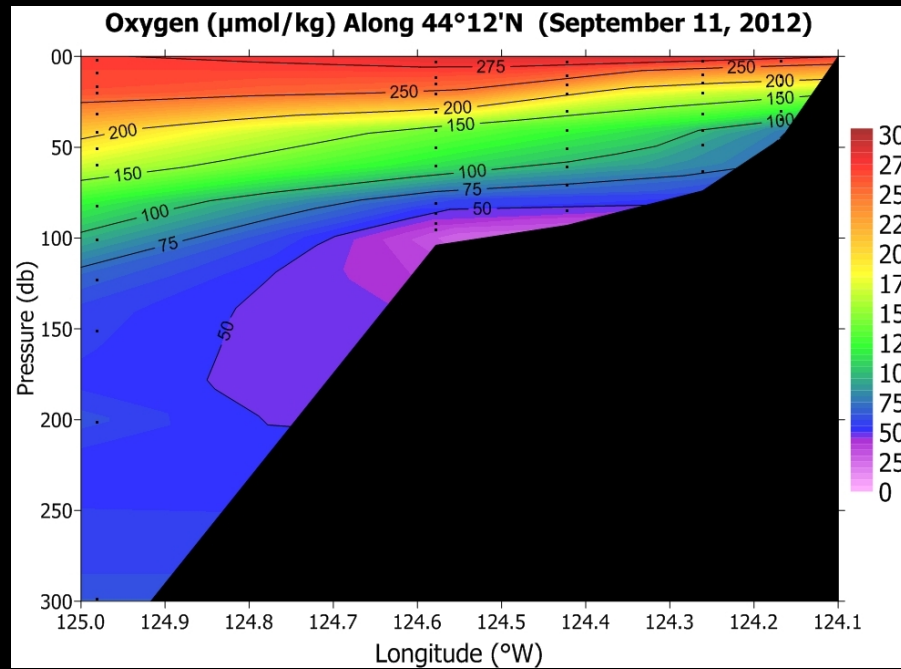
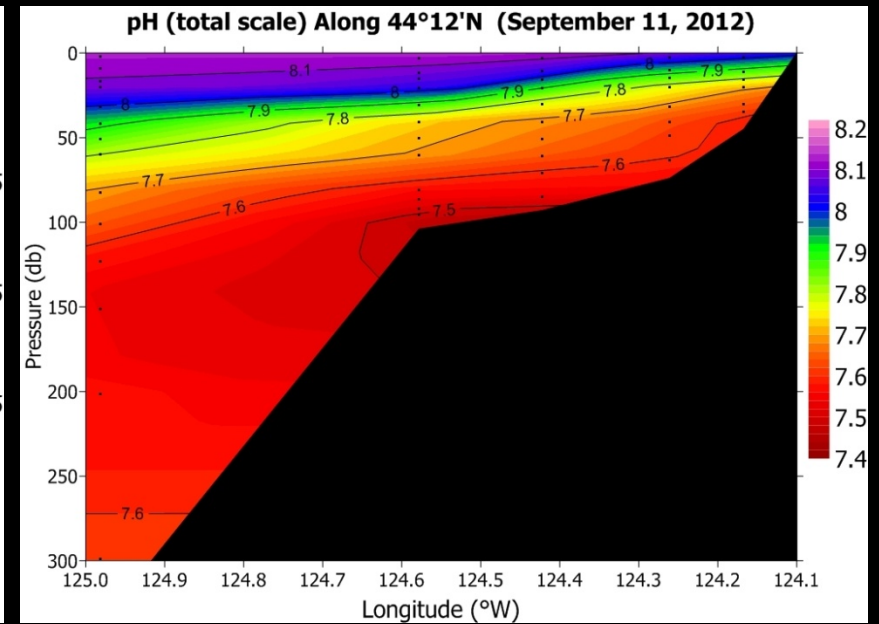
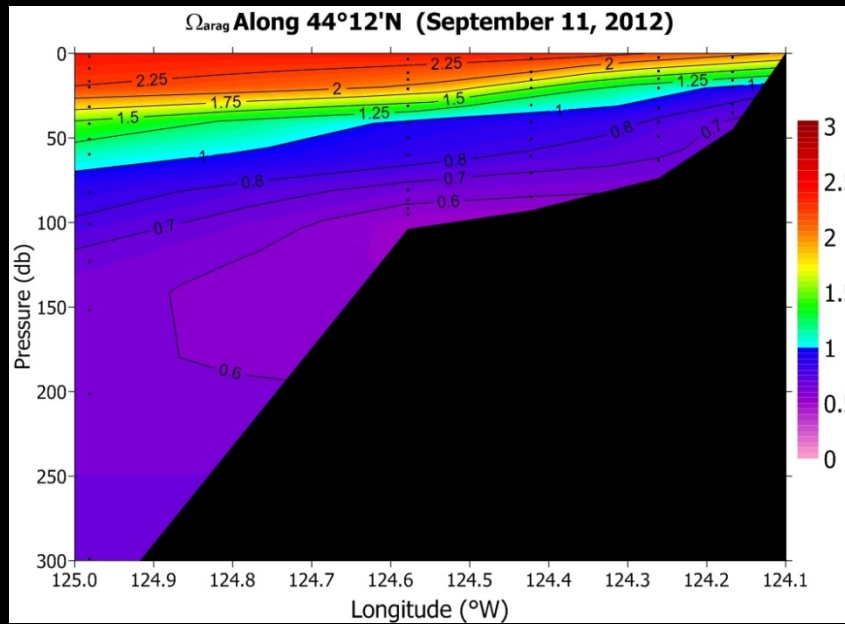


NOAA West Coast Ocean Acidification Program

Continental shelf carbon budgets, dynamics, and processes

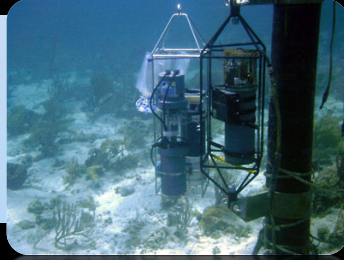
2011 August – September aragonite saturation state





NOAA National Ocean and Great Lakes Acidification Research Plan

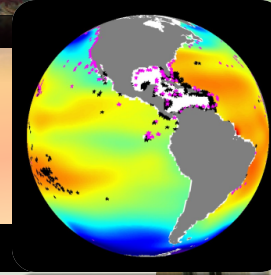
Monitor trends



Ecosystem Impacts



Model changes & responses



Develop adaptation strategies



Conduct education and outreach



Data management and synthesis

Carbon Wave Glider

