Global to local:
Understanding ecosystem response and stakeholder needs in a changing ocean

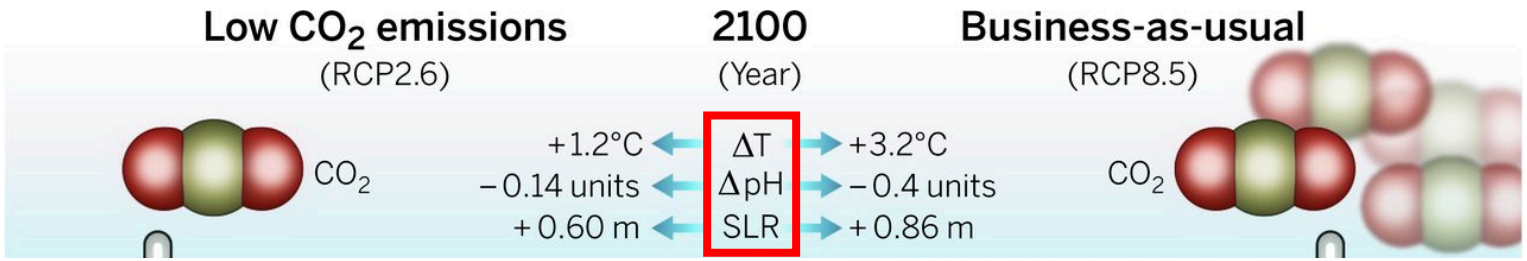
Jan Newton
University of Washington

Science 3 July 2015:
Vol. 349 no. 6243
DOI: 10.1126/science.aac4722

Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios

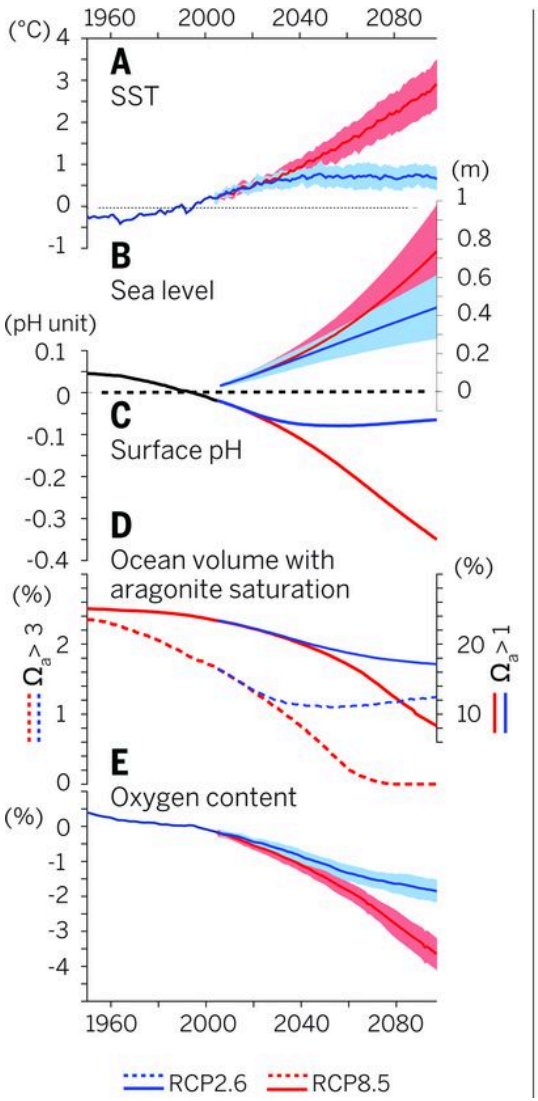
J.-P. Gattuso[1,2,3,*], A. Magnan[3], R. Billé[4], W. W. L. Cheung[5], E. L. Howes[6], F. Joos[7], D. Allemand[8,9], L. Bopp[10], S. R. Cooley[11], C. M. Eakin[12], O. Hoegh-Guldberg[13], R. P. Kelly[14], H.-O. Pörtner[6], A. D. Rogers[15], J. M. Baxter[16], D. Laffoley[17], D. Osborn[18], A. Rankovic[3,19], J. Rochette[3], U. R. Sumaila[20], S. Treyer[3], C. Turley[21]

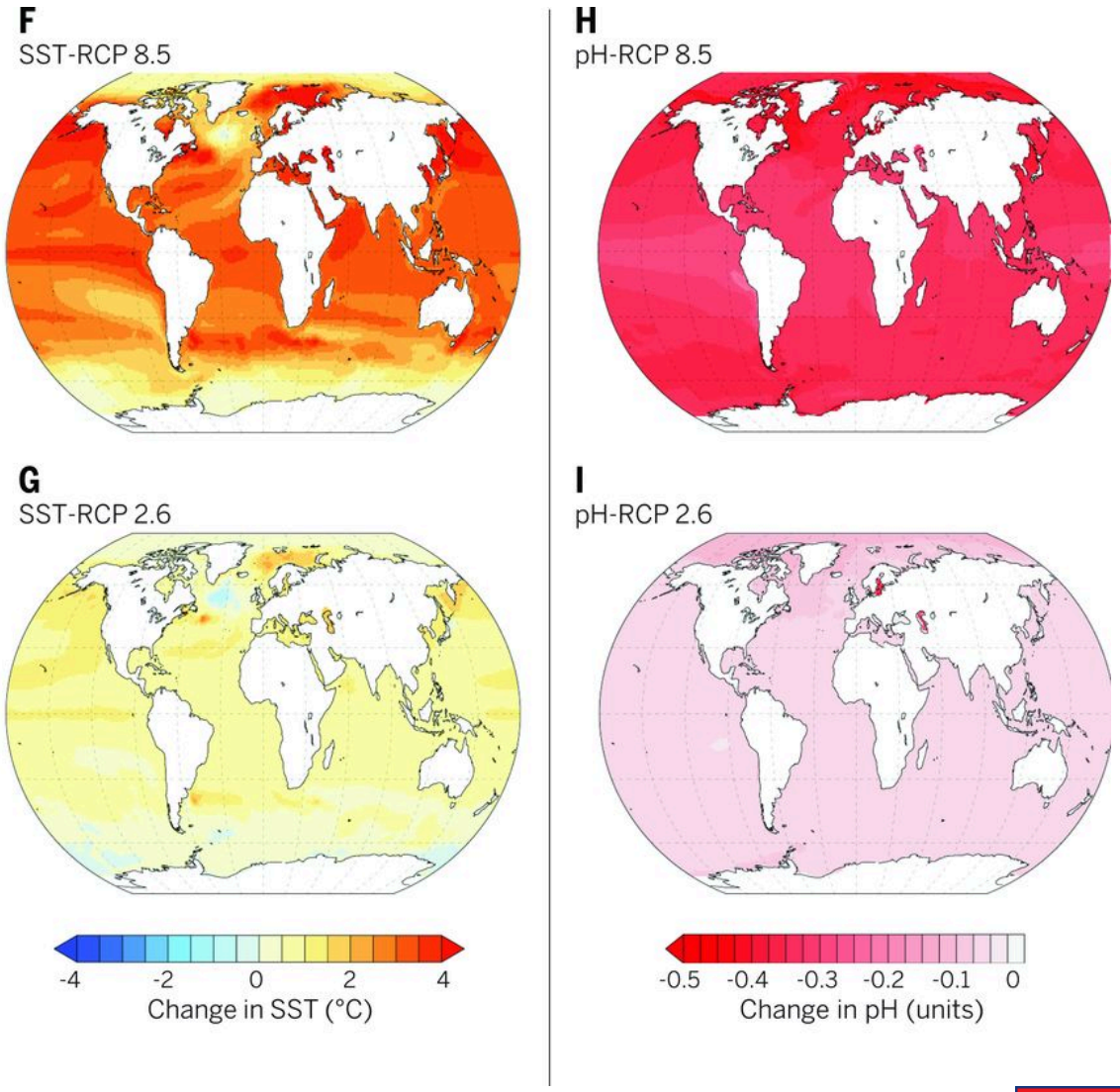
Changes in ocean physics and chemistry and impacts on organisms and ecosystem services according to stringent (RCP2.6) and high business-as-usual (RCP8.5) CO2 emissions scenarios.



J.-P. Gattuso et al. Science 2015;349:aac4722

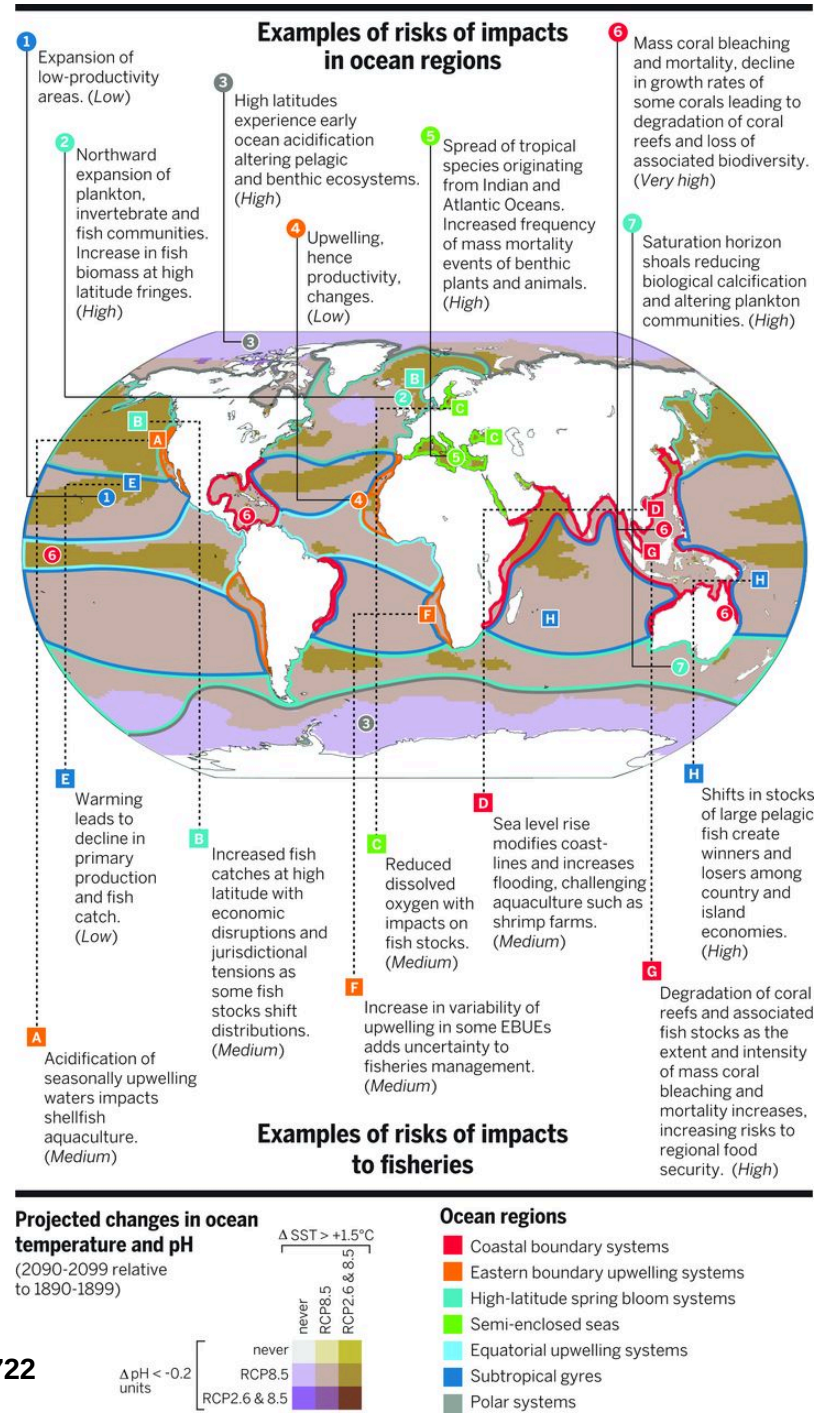
Environmental changes over the industrial period and the 21st century for a business-as-usual scenario and a stringent emissions scenario consistent with the UNFCCC target of increase in global surface temperature by 2°C.





J.-P. Gattuso et al. Science 2015;349:aac4722
Published by AAAS

Regional changes in the physical system and associated risks for natural and human-managed systems.

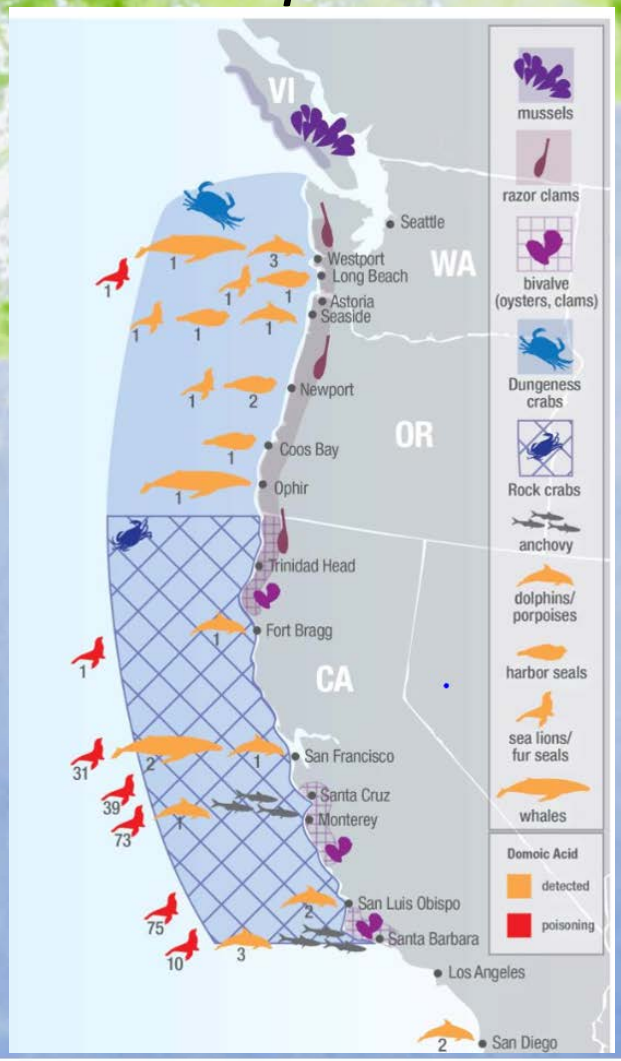


J.-P. Gattuso et al. Science 2015;349:aac4722
Published by AAAS

“An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions”

McCabe et al., 2016

Fisheries and marine mammal impacts:



An extreme climatic event alters marine ecosystem structure in a global biodiversity hotspot

Thomas Wernberg Dan A. Smale Fernando Tuya Mads S. Thomsen Timothy J. Langlois Thibaut de Bettignies Scott Bennett Cecile S. Rousseaux

Nature Climate Change **3**, 78–82 (2013)

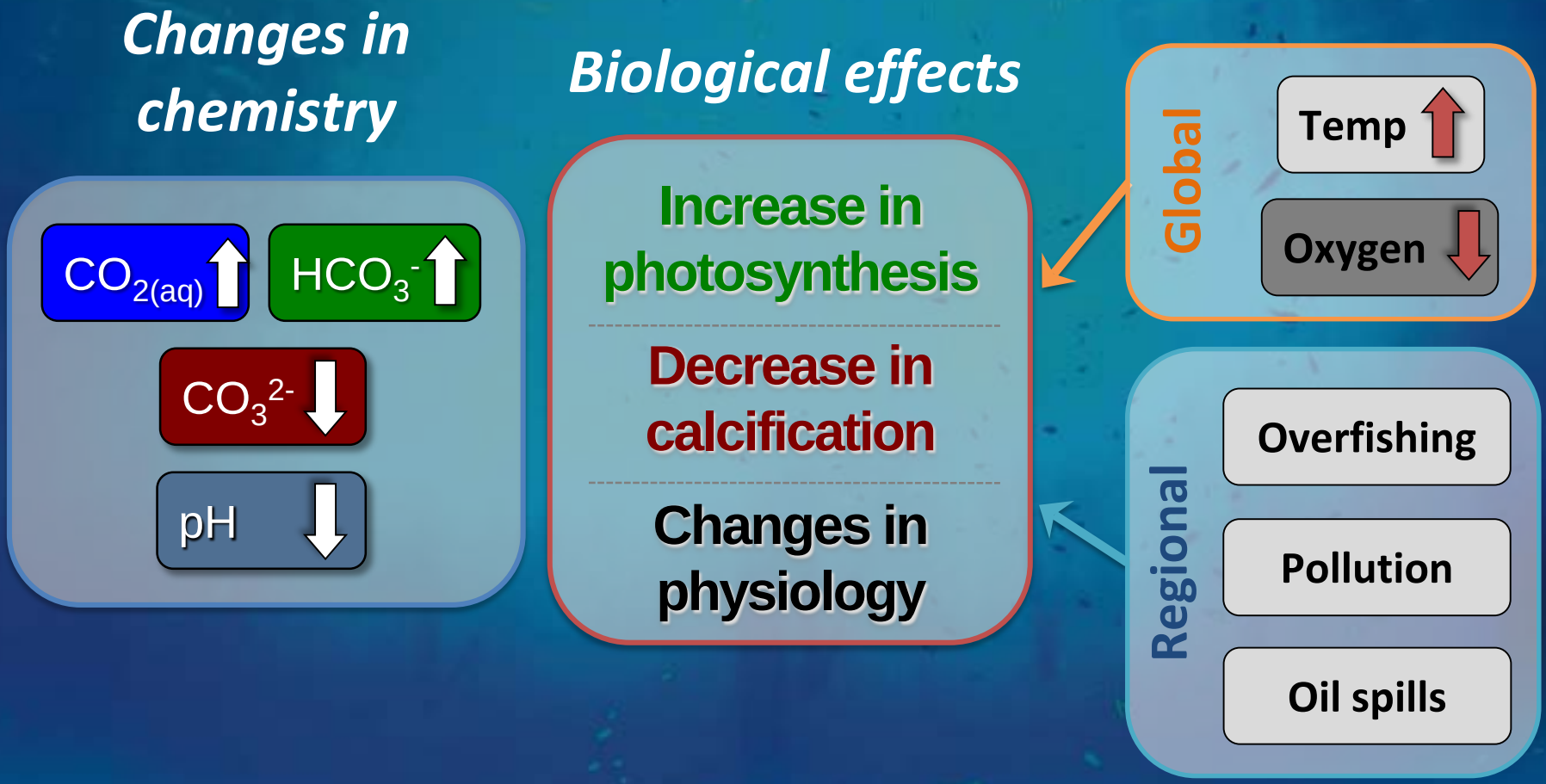
"We conclude that extreme climatic events are key drivers of biodiversity patterns and that the frequency and intensity of such episodes have major implications for predictive models of species distributions and ecosystem structure…"

Marine Heat Wave: 2011

7000 acres dead mangrove in Australia:

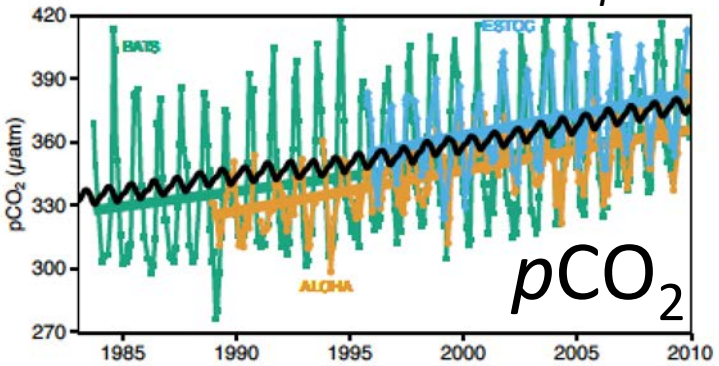
Aerial footage of 'unprecedented' mangrove die-off in the Gulf of Carpentaria in Australia. The die-off is thought to be a result of low rainfall and warm temperatures. Photograph: Professor Norm Duke/James Cook University

How does CO_2 in seawater affect marine life ?



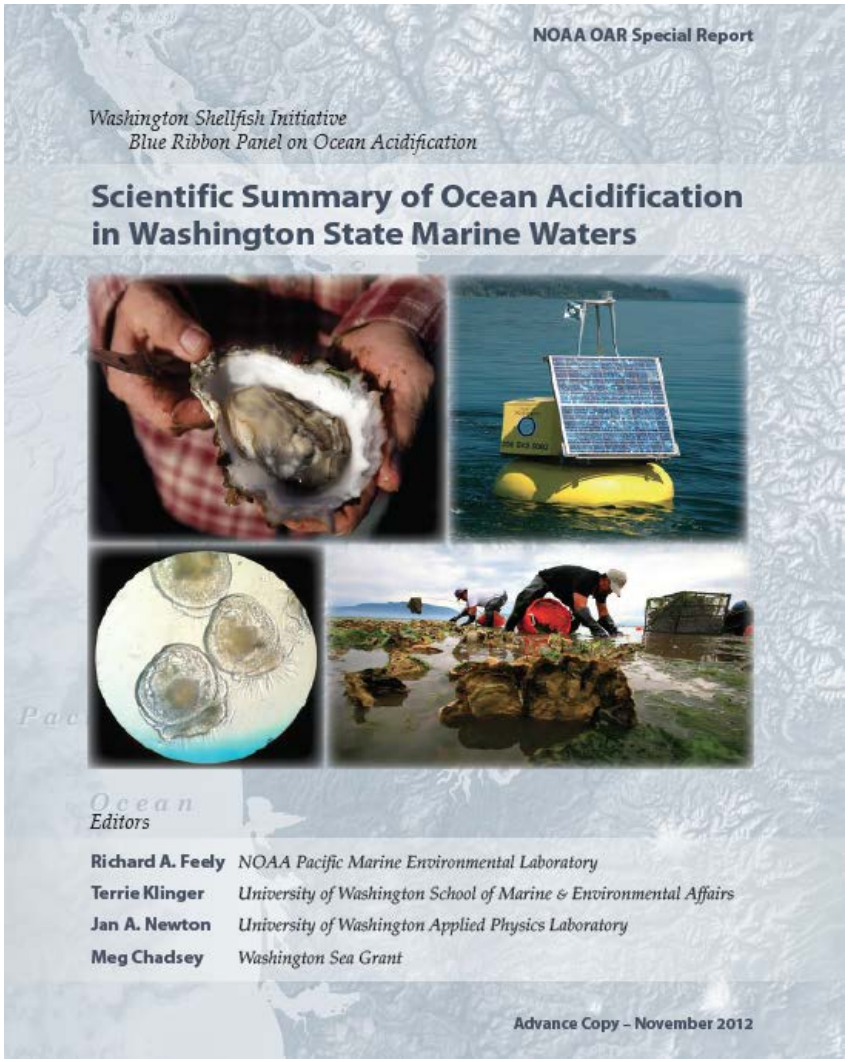
J. Kleypas, NCAR

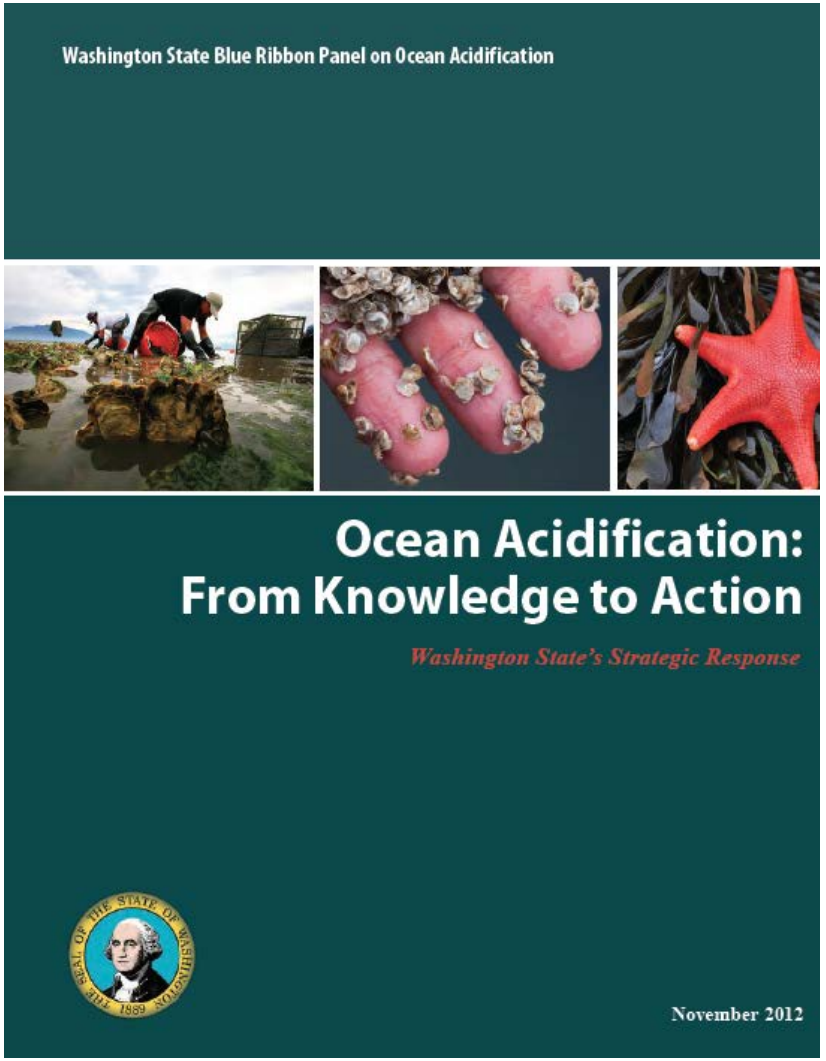
Source: IPCC Report



OA is
a global condition
with
local effects

Washington State Blue Ribbon Panel





http://www.ecy.wa.gov/water/marine/oceanacidification.html

What's at Stake for Washington's Tribes?

Continued identity and cultural survival of Washington's coastal tribes

- Washington tribes depend upon shellfish for food, income, and connection to their cultural heritage.

Photos: Northwest Indian Fisheries Commission

What's at Stake for Washington's Economy?

Valuable wild and recreational fisheries

- Impacts to marine food webs could affect Washington's seafood industry, which generates over 42,000 jobs in Washington and contributes at least $1.7 billion to gross state product.

- Recreational oyster and clam harvesters contribute more than $27 million annually to coastal economies.

Photos (left to right): Washington Association of Conservation Districts, US Dept. Agriculture, City of Seattle

What's at Stake for Washington's Economy?



The most productive commercial shellfish industry on the West Coast

- Washington's shellfish industry generates $270 million annually, and directly and indirectly supports 3,200 jobs.

- Annual sales of farmed shellfish from Washington account for almost 85% of U.S. West Coast sales (including Alaska).

Photos: Benjamin Drummond (left and right); Bryan Penttila (center)

NOAA HOME WEATHER OCEANS FISHERIES CHARTING SATELLITES CLIMATE RESEARCH COASTS CAREERS

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

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'Like putting headlights on a car'

Pacific oysters gain from IOOS® data

Promoting Economic Vitality

About six years ago, production at some Pacific Northwest oyster hatcheries began declining at an alarming rate, posing severe economic impact and challenging a way of life held by shellfish growers for more than 130 years.

By 2008, the oyster harvest at Whiskey Creek, a major Oregon supplier to the majority of West Coast oyster farmers, plummeted 80 percent. At about the same time, corrosive, acidified seawater was hitting the shores of the Pacific.

Something had to be done. Oyster production accounts for more than $84 million of the West Coast shellfish industry, which supports more than 3,000 jobs.

"When you see oyster shells dissolving in water, there's a compelling need to know why," says Bill Dewey of Taylor Shellfish Farms in Washington state.

Thanks to a $500,000 federal investment in monitoring coastal seawater strengthened by data and observational information from the U.S. **Integrated Ocean Observing System** (IOOS®) and the **NOAA Ocean Acidification Program**, oyster hatcheries on the verge of collapse just a few years ago are again major contributors to the $111 million West Coast shellfish industry.

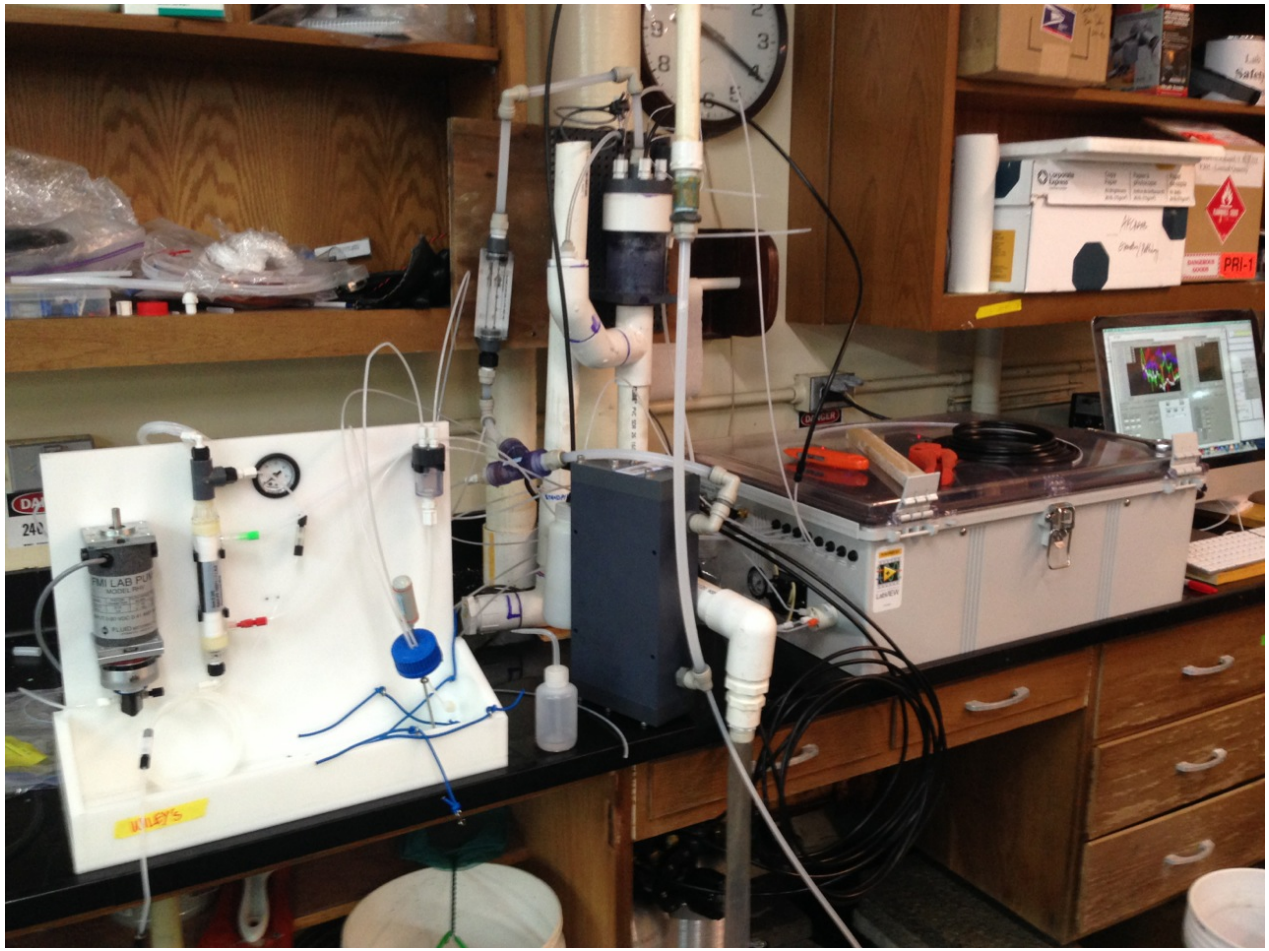
IOOS is a NOAA-led interagency and regional effort aimed at "knowing" — that

IOOS partners in the Northwest Association of Networked Ocean Observing Systems (NANOOS) deployed this buoy in 2010 as part of a three-piece observing array to assess issues in the Northwest, including **ocean acidification**, **hypoxia and harmful algal blooms**, and **climate change**. The coastal buoy will aid computer models that predict ocean and atmospheric conditions. Known as "Chá bă," the buoy is named for the Native American word (pronounced "chay buh") for "whale tail."

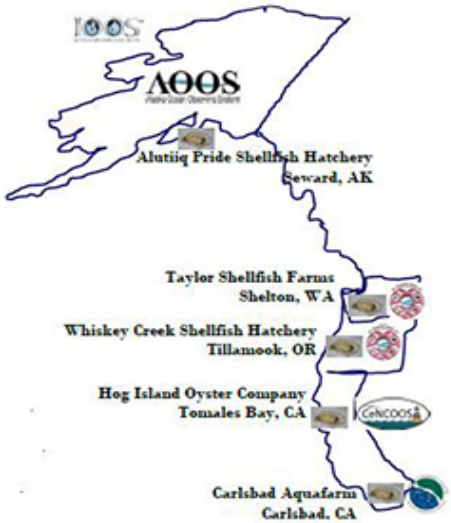
(Photo courtesy of Dr. John Payne, Pacific Ocean Shelf

"Putting an IOOS buoy in the water is like putting headlights on a car. It lets us see changing water conditions in real time," says Mark Wiegardt, co-owner of Whiskey Creek Shellfish Hatchery.

Sensing OA in hatcheries



- “Burke-o-lator”



NOAA funded Ocean Technology award

"Headlights on High"

AOOS
Alaska Ocean Observing System

Alutiiq Pride Shellfish Hatchery
Seward, AK

NANOOS

Taylor Shellfish Hatchery
Quilcene, WA

Whiskey Creek Shellfish Hatchery
Tillamook, OR

CeNCOOS

Hog Island Oyster Company
Tomales Bay, CA

Southern California Coastal Ocean Observing System

Carlsbad Aquafarm
Carlsbad, CA

STATE OF OREGON 1859

OAP
OCEAN ACIDIFICATION PROGRAM

IOOS
Integrated Ocean Observing System

Science-Grower Partnerships

Wiley Evans,
Hakai Institute

Simone Alin,
NOAA PMEL

QA

Tessa Hill,
UC Davis

Burke Hales,
OSU

Todd Martz,
SIO

AOOS
Alaska Ocean Observing System

Alutiiq Pride Shellfish Hatchery
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Whiskey Creek Shellfish Hatchery
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STATE OF OREGON
1859

OAP
OCEAN ACIDIFICATION PROGRAM

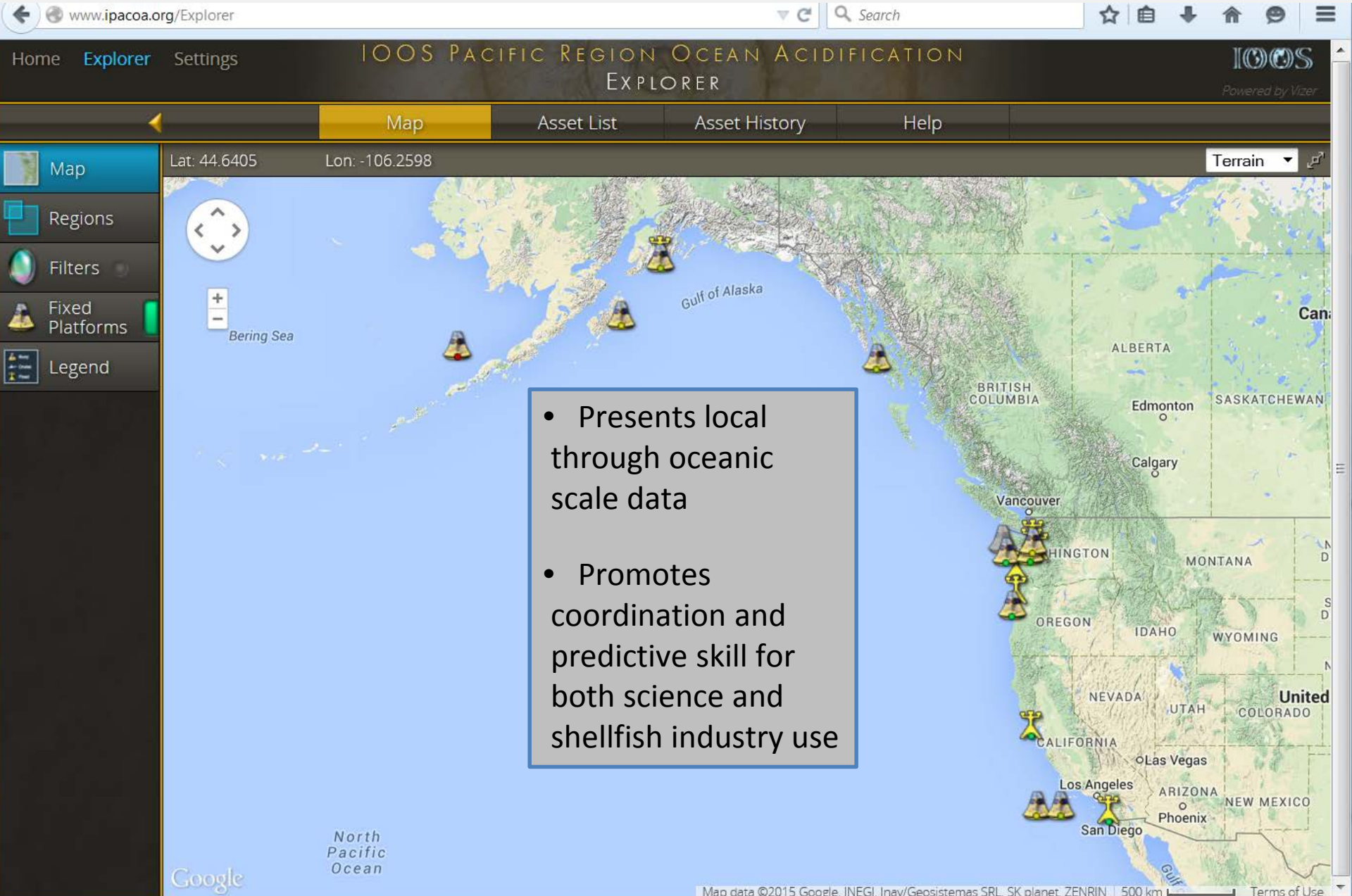
IOOS
Integrated Ocean Observing System

U.S. IOOS Pacific Region Ocean Acidification data portal

- **Five** U.S. IOOS Pacific Regions:
  - AOOS, NANOOS, CeNCOOS, SCCOOS, and PacIOOS
- Canadian partner: Hakai
- **Seven** shellfish hatcheries:
  - Alutiiq, OceansAlaska, Fanny Bay, Taylor, Whiskey Creek, Hog Island, Carlsbad
- **One** data portal: **IPACOA (www.ipacoa.org)**
- Funded by a joint U.S. IOOS and NOAA OAP project to enhance OA monitoring in shellfish hatcheries

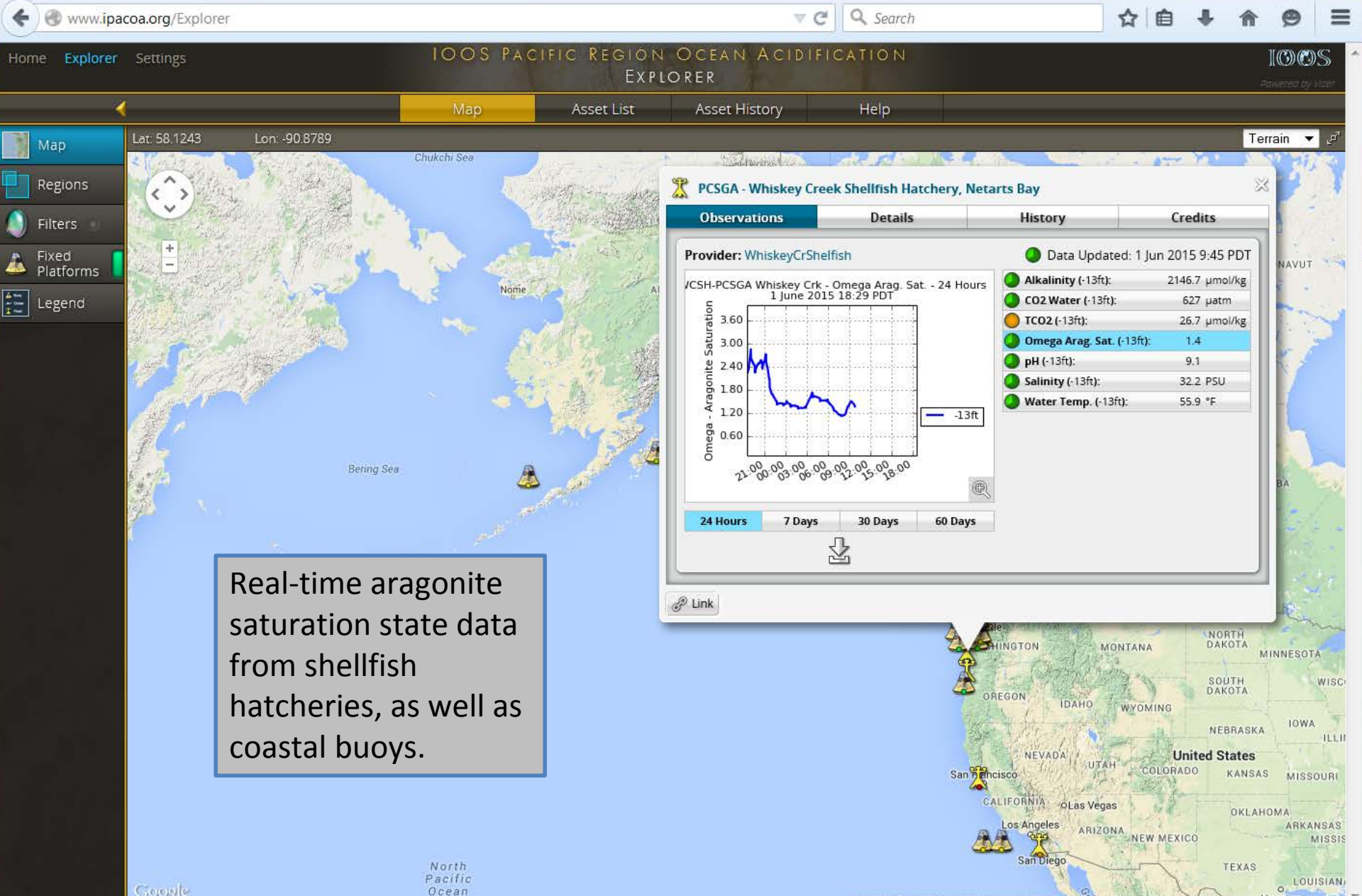
Allows access to real-time data and information links; eventually links to manuals, FAQ, etc. in order to facilitate a 'community of practice' for monitoring.

IOOS Pacific Region Ocean Acidification Data Portal

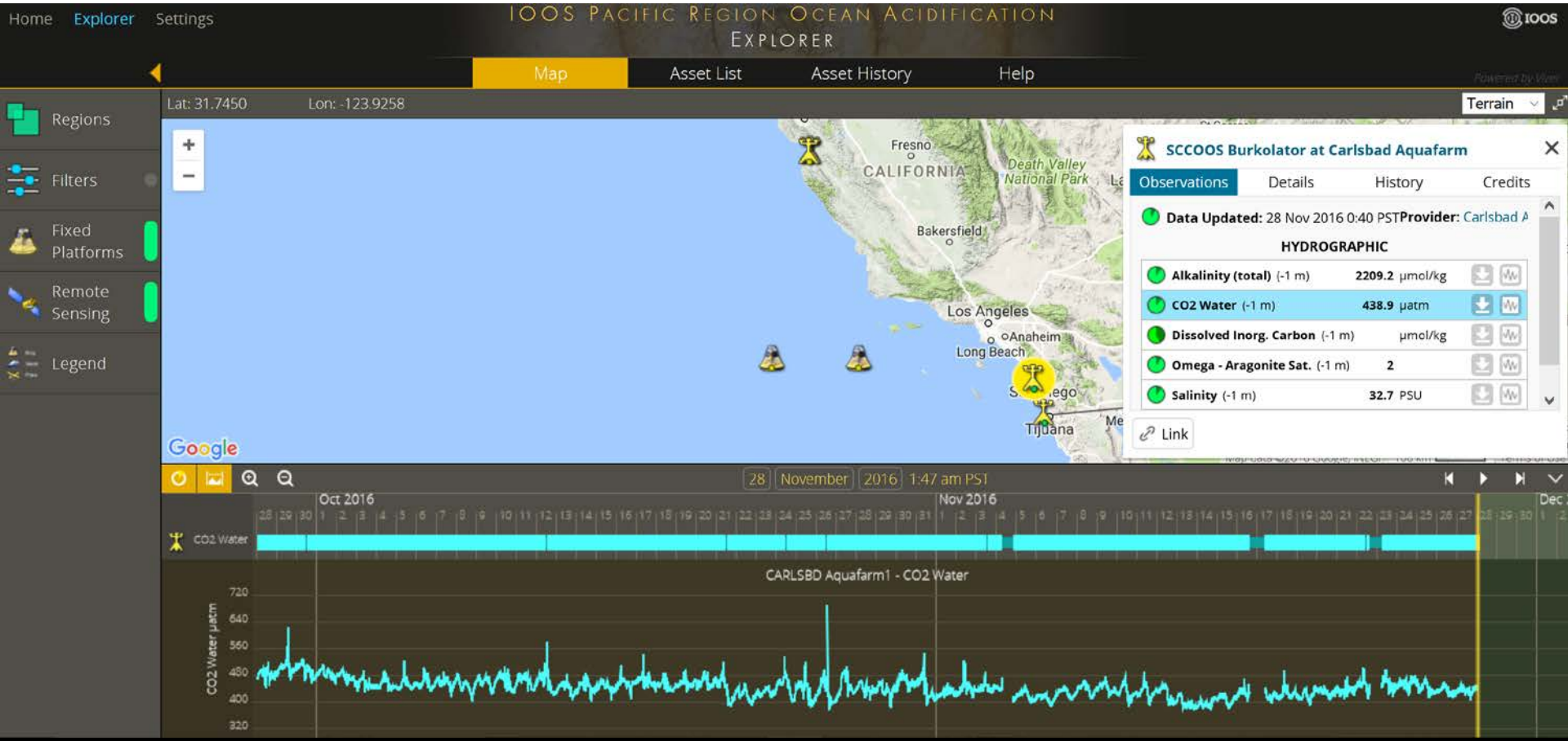


- Presents local through oceanic scale data
- Promotes coordination and predictive skill for both science and shellfish industry use

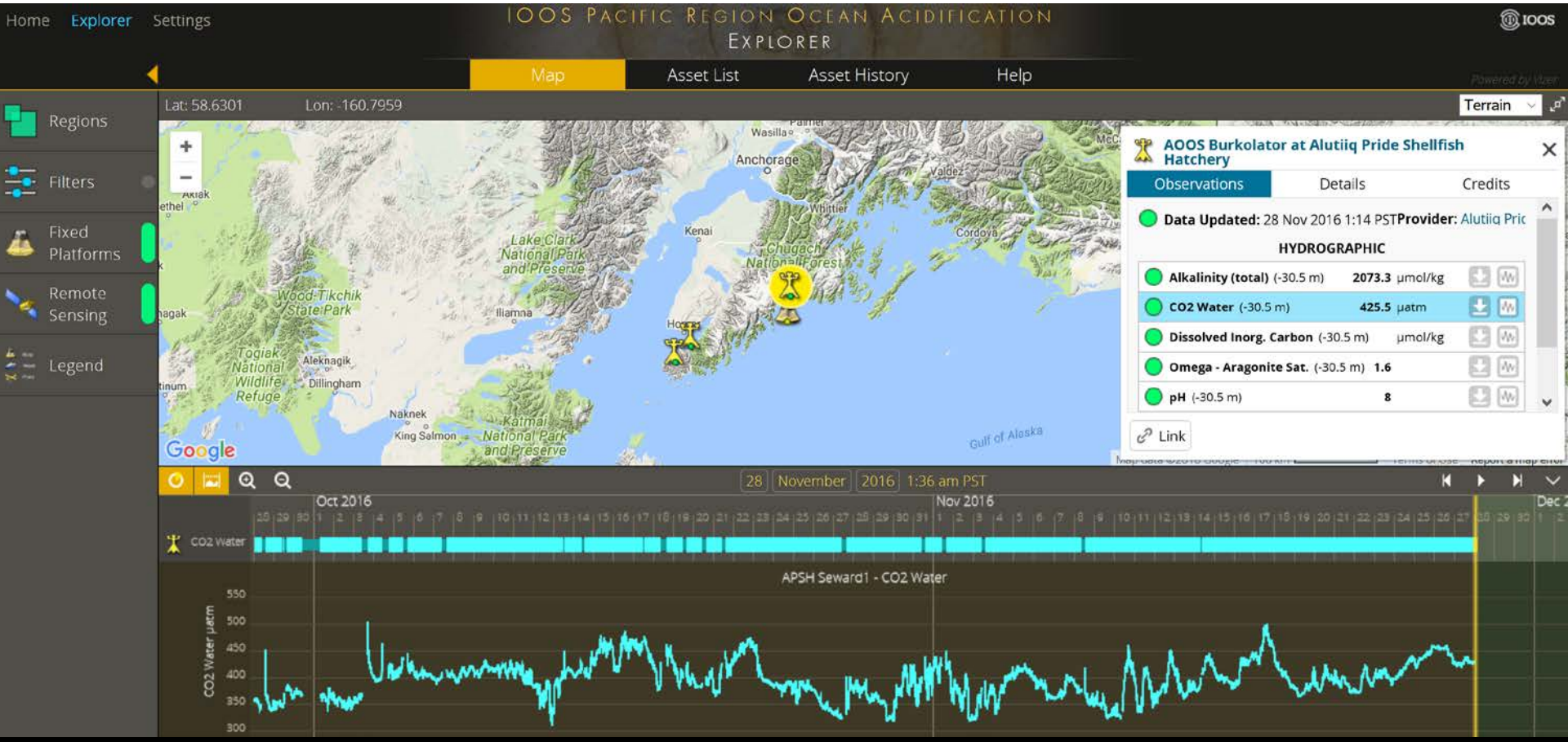
IOOS Pacific Region Ocean Acidification Data Portal



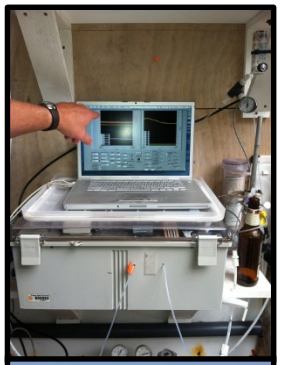
Carlsbad Aquafarm, CA: Oct-Nov 2016



Alutiiq Hatchery, AK: Oct-Nov 2016

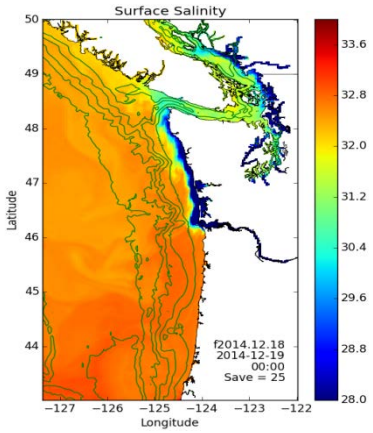


Lines of defense for adaptation



Real-time observations at the hatchery or growing sites

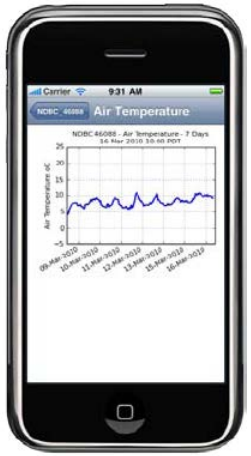
Real-time observations at the adjacent estuary, sea, or ocean



Regional forecasts on days to weeks scale (weather)

Forecasts at months to years scale (seasonal to interannual)

Communicated !!



GOA-ON

Global Ocean Acidification Observing Network

The Global Ocean Acidification Observing Network

NOAA

Global Ocean Observing System

IOOS

UNESCO

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

UK Ocean Acidification Research Programme

IAEA

Ocean Acidification International Coordination Centre

OA-ICC

BLUE PLANET Oceans and Society

INTERNATIONAL OCEAN CARBON COORDINATION PROJECT

IOCCP

What is GOA-ON?

GOA-ON
Global Ocean Acidification Observing Network

The **Global Ocean Acidification Observing Network** (GOA-ON) is a **international partnership** to:

1. **Document the status and progress of ocean acidification** in open-ocean, coastal, estuarine, and coral reef environments,

2. **Understand the impacts of ocean acidification on diverse marine ecosystems and societies**, and

3. **Support forecasts of ocean acidification conditions.**

www.goa-on.org

Why is a global approach needed ?

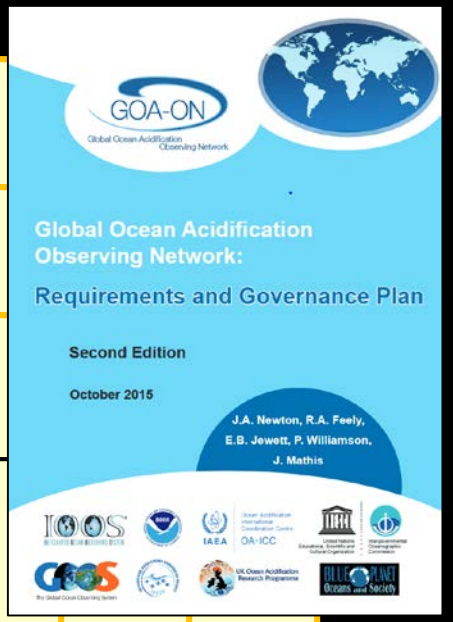
Processes are occurring at global scales; therefore we need to go beyond local measurements and **observe on global scales in order to understand OA and its drivers correctly.**

We need information and data products that can **inform policy and the public with respect to global status of OA and implications** for overall ecosystem health (status) of the planet.

We need sufficient data and understanding to **develop predictive skills and early warning systems**. This requires coverage at appropriate scales, nesting local observations within global context.

Data Requirements

GOA-ON
Global Ocean Acidification Observing Network



Coral reefs

Coasts & shelf seas

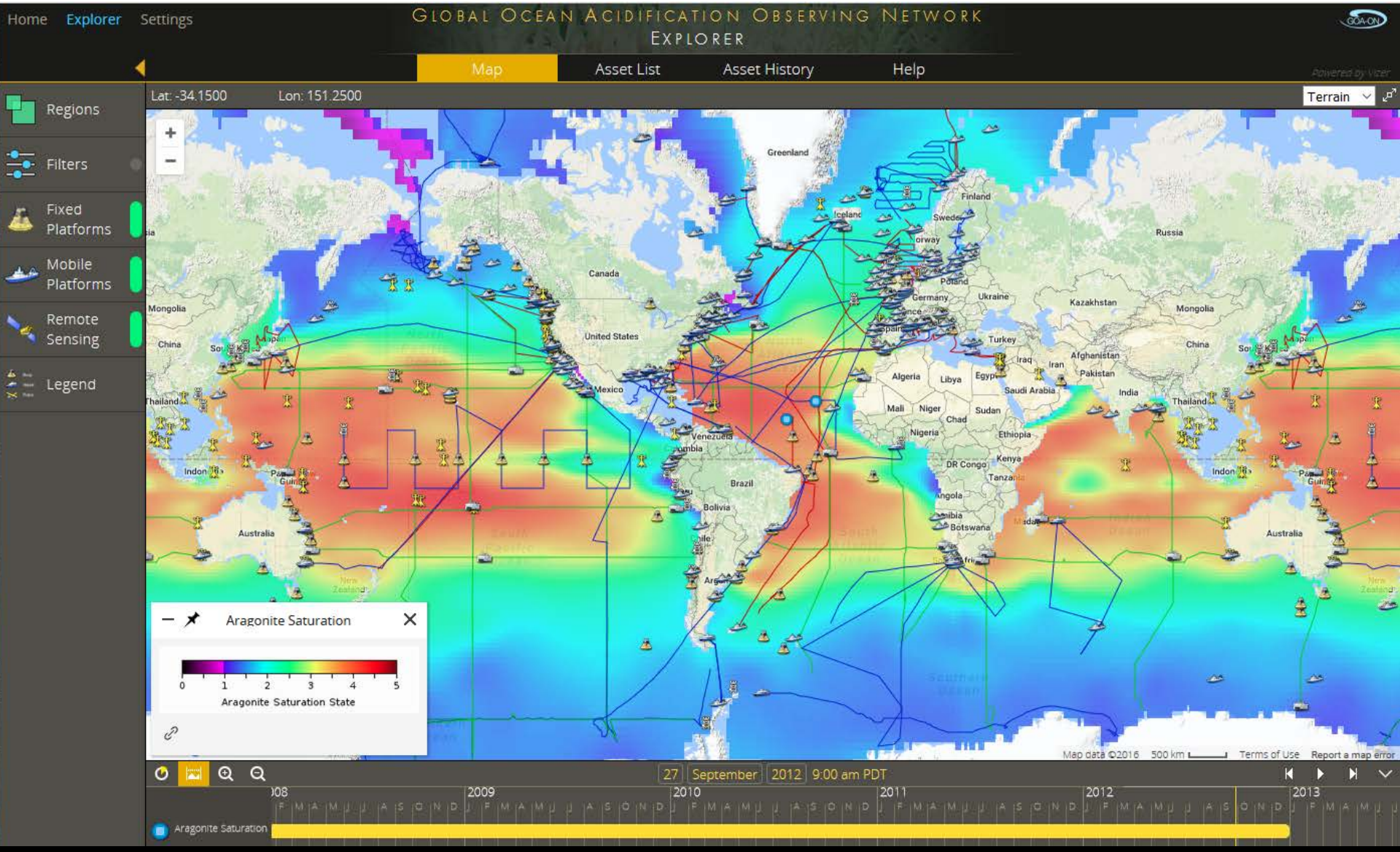
Open ocean

Goal 1 OA conditions	Goal 2 Ecosystem response	Goal 3 OA modeling
L1: carbonate-system constraint, T, S, O, *fluorescence, irradiance* *L2:* nutrients, bio-optics, transport, meteorology, trace metals... *L3:* capability-specific	*L1:* biomass of functional groups (phytoplankton, zoo-plankton & microbes) *L2:* species; processes incl. growth, grazing & respiration *L3:* capability-specific	Inputs to models

The GOA-ON interactive data portal

Featuring global OA data, asset inventory, metadata, data synthesis products, etc.

GOA-ON
Global Ocean Acidification Observing Network



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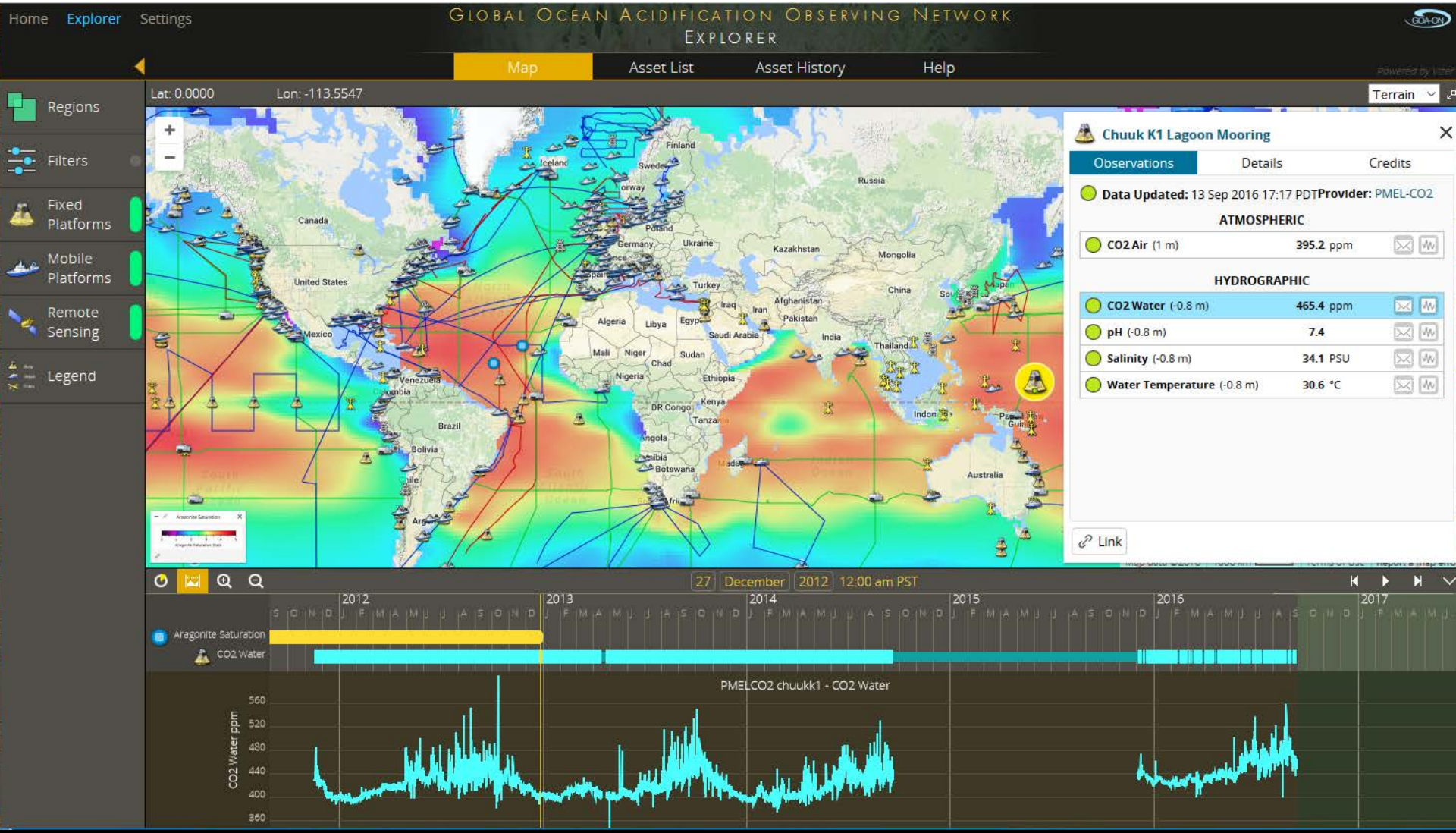
GOA-ON
Global Ocean Acidification Observing Network



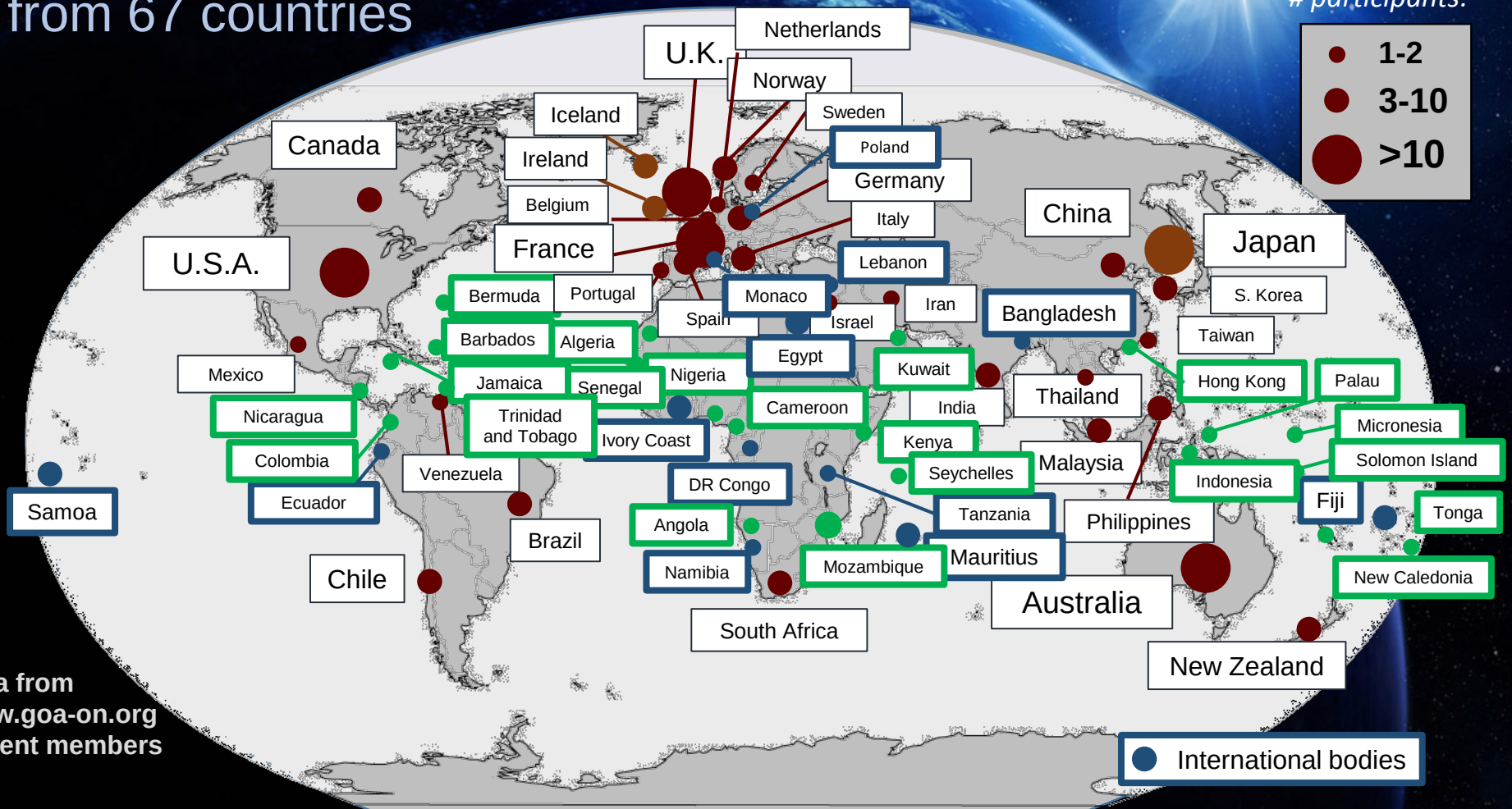
GOA-ON
Global Ocean Acidification Observing Network

GOA-ON Membership Expansion

GOA-ON now (Sep 2016)

➢ Several regional trainings (2016)

Network of 330 scientists
from 67 countries



Data from
www.goa-on.org
current members
list

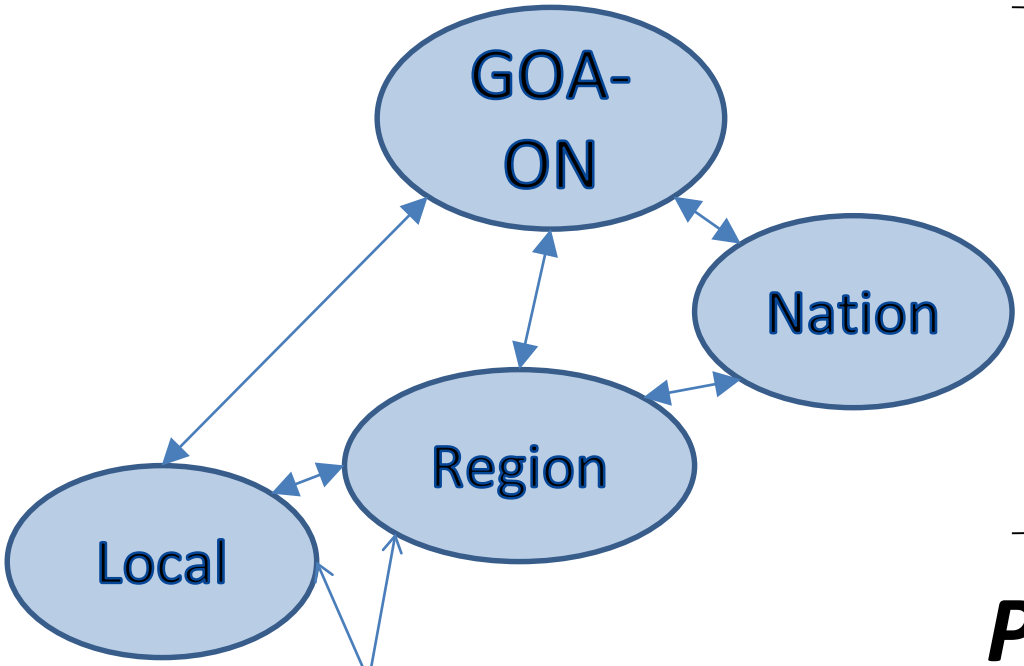
GOA-ON

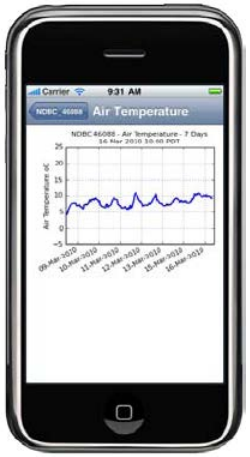
Global Ocean Acidification Observing Network

130 scientists from 37 nations

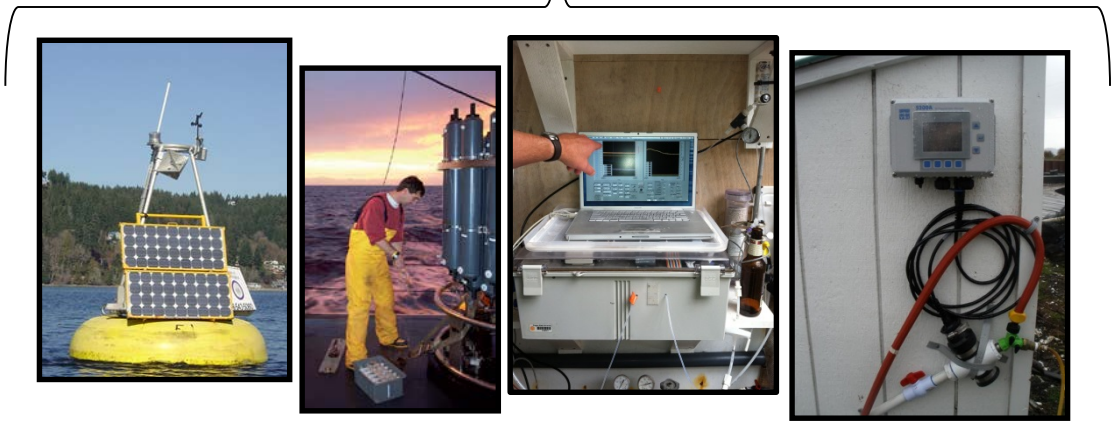
3rd workshop, Hobart, TAS

Integration of local through global





Weekly Trends



Partnerships:

Governments
Academia
Industry
NGOs
etc.

Understanding ecosystem response and stakeholder needs in a changing ocean

- We need local through global scale observations **in order to get either correct**

- This issue **demands our coordination**, networked skill, and open analysis